

# ANNUAL REPORT

## VOLUME 3

## PART 3

## TASK 3: SPECIAL STUDIES

REPORT NO. AR-0142-91-002

September 27, 1991

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**GUIDANCE, NAVIGATION AND CONTROL**

**DIGITAL EMULATION TECHNOLOGY LABORATORY**

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**COMPUTER ENGINEERING RESEARCH LABORATORY**

Georgia Institute of Technology

Atlanta, Georgia 30332-0540

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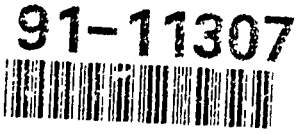

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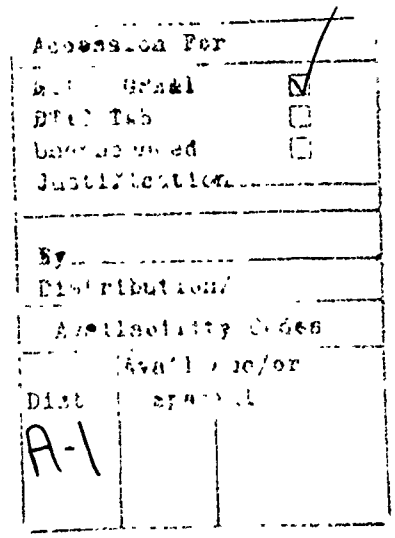

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**Authors**

**Cecil O. Alford, Richard M. Pitts and Philip R. Bingham**

**COMPUTER ENGINEERING RESEARCH LABORATORY**

Georgia Institute of Technology

Atlanta, Georgia 30332-0540


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| | |
|---|---|
| **Eugene L. Sanders** | **Cecil O. Alford** |
| **USASDC** | **Georgia Tech** |
| **Contract Monitor** | **Project Director** |

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PART 3

TASK 3: SPECIAL STUDIES

7. Appendix B: EXOSIM v2.0 Midcourse and Terminal Phases

## B.1 Mainline (FORTRAN)

### B.1.1 Uup00.for

```
c       PROGRAM EXOSIM
C-------------------------------------------------------------------------C
C---------------- Declare and initialize variables  ----------------------C
C-------------------------------------------------------------------------C


      IMPLICIT REAL          (A-H)
      IMPLICIT REAL          (O-Z)

      CHARACTER*128 MESSAGE
C     THE FOLLOWING COMMON BLOCKS USED FOR MIDFLIGHT CAPABILITIES ONLY

      COMMON / STORAG / XINT    , TINT    , XDOTL
      COMMON / RMASS  / TLSTM   , MASSL
      COMMON / RMISSL / XYZLCH

      REAL  XINT(50)      ,  TINT(50)      ,  XDOTL(50)
      REAL  XYZLCH(3)     ,  MASSL

C     OUTPUTS

      REAL  MXVCS         ,  MYVCS         ,  MZVCS
      REAL  MXACS         ,  MYACS         ,  MZACS
      REAL  MX            ,  MY            ,  MZ
      REAL  MACH
      REAL  MDOTV         ,  MDOTA
      REAL  CIM(9)

C     NAMELIST INPUTS

      REAL  IXX           ,  IYY           ,  IZZ
      REAL  MASS
      REAL  IMPULS        ,  QUAT(4)       ,  MDOT
      REAL  QUATD(4)

      INTEGER           SEKTYP

      REAL TSTEP,DELT,LATLP,LONGLP
      REAL TMSUDRIV,TMSUSTEP

      double precision d_xd,d_yd,d_zd

* DATA INITIALIZATION
$INCLUDE('^/INCLUDE/SSDATA35.DAT')
$INCLUDE('^/INCLUDE/SSDATA38.DAT')
$INCLUDE('^/INCLUDE/SSDATA39.DAT')
$INCLUDE('^/INCLUDE/SSDATA42.DAT')
$INCLUDE('^/INCLUDE/SSDATA44.DAT')
$INCLUDE('^/INCLUDE/SSDATA45.DAT')
$INCLUDE('^/INCLUDE/SSDATA46.DAT')
$INCLUDE('^/INCLUDE/SSDATA47.DAT')
$INCLUDE('^/INCLUDE/SSDATA48.DAT')
$INCLUDE('^/INCLUDE/SSDATA49.DAT')
$INCLUDE('^/INCLUDE/SSDATA50.DAT')
$INCLUDE('^/INCLUDE/SSDATA01.DAT')
$INCLUDE('^/INCLUDE/SSDATA17.DAT')
$INCLUDE('^/INCLUDE/SSDATA18.DAT')
$INCLUDE('^/INCLUDE/SSDATA21.DAT')
```

```
$INCLUDE('^/INCLUDE/SSDATA22.DAT')
$INCLUDE('^/INCLUDE/SSDATA23.DAT')
$INCLUDE('^/INCLUDE/SSDATA28.DAT')
$INCLUDE('^/INCLUDE/SSDATA29.DAT')
$INCLUDE('^/INCLUDE/SSDATA30.DAT')
$INCLUDE('^/INCLUDE/SSDATA71.DAT')
$INCLUDE('^/INCLUDE/SSTIMING.DAT')
$INCLUDE('SSp00.DAT')

* INITIALIZE 80x87
      CALL CW87



C-------------------------------------------------------------------------C
C----------------------------- MAIN EXECUTION LOOP -----------------------C
C-------------------------------------------------------------------------C
C                               Execution of all events is performed      C
C                               within this loop                          C
C                                                                         C
C-------------------------------------------------------------------------C

c     call initialize_timing()

 1000 CONTINUE

c     call start_timing(0)

C     WRITE(*,*)'--------------BEGINNING OF LOOP-----------------'

C-------------------------------------------------------------------------C
C---------------------------- MISSILE STATE UPDATE MODULE ----------------C
C-------------------------------------------------------------------------C
C                             Integrate missile states to current time    C
C                                                                         C
C-------------------------------------------------------------------------C
C1001     format(1x,f7.4,3(a,1pe13.6))
C1002     format(1x,3(a,1pe13.6))
C      write(message,1001)t,'p ',p,' q ',q,' r ',r
C      call outmes(message)
C      write(message,1002)'       pd ',pd,' qd ',qd,' rd ',rd
C      call outmes(message)
C      write(message,1002)'   cim(1) ',cim(1),' (2) ',cim(2),
C     *                          ' (3) ',cim(3)
C      call outmes(message)
C      write(message,1002)'      (4) ',cim(4),' (5) ',cim(5),
C     *                          ' (6) ',cim(6)
C      call outmes(message)
C      write(message,1002)'      (7) ',cim(7),' (8) ',cim(8),
C     *                          ' (9) ',cim(9)
C      call outmes(message)
      IF ( tstep .gE. tmsudriv ) THEN

         tmsudriv = tmsudriv + tmsustep

C-------------------------------------------------------------------------C
C---------------------------- MASS PROPERTIES MODULE ---------------------C
C-------------------------------------------------------------------------C
C                             Update mass flow rate, cg and inertia       C
C                                                                         C
C-------------------------------------------------------------------------C


         CALL MASSPR(T,MDOTA,MDOTV,MASS,EISP,IMASS,
```

```
     .              MDOT,WEIGHT,WDOTTP,WDOTKV,WDOTTI,IXX,
     .              IYY,IZZ)

C-------------------------------------------------------------------C
C---------------------------- VEHICLE STATES MODULE ----------------C
C-------------------------------------------------------------------C
C                              Compute missile state derivatives    C
C                                                                   C
C-------------------------------------------------------------------C


         CALL MISSIL2(T,QUAT,CIM,P,Q,R,IXX,IYY,IZZ,
     .              MXACS,MXVCS,MYACS,MYVCS,MZACS,
     .              MZVCS,XD,YD,ZD,NCLEAR,PD,QD,RD,
     .              MX,MY,MZ,U,V,W,QUATD,PHI,THT,PSI)


C-------------------------------------------------------------------C
C                              MISSILE STATE INTEGRATION MODULE     C
C-------------------------------------------------------------------C
C                              Revise missile states using derivatives C
C                              just computed . Missile states must not C
C                              be integrated if a table lookup index  C
C                              transition has occurred since the last C
C                              integration step . The next integration C
C                              step should be rescheduled to coincide C
C                              with the earliest detected table lookup C
C                              index transition instead . Otherwise   C
C                              schedule the next integration step to  C
C                              occur at the default step size .       C
C                                                                   C
C-------------------------------------------------------------------C


C        TRAPEZOIDAL INTEGRATION FOR SIMPLICITY

         CALL spINTEG ( MASS     , MDOT      , T ,  1 )
         CALL spINTEG ( WKV      , WDOTKV    , T ,  5 )
         CALL spINTEG ( P        , PD        , T , 12 )
         CALL spINTEG ( Q        , QD        , T , 13 )
         CALL spINTEG ( R        , RD        , T , 14 )
         CALL spINTEG ( QUAT(1)  , QUATD(1)  , T , 15 )
         CALL spINTEG ( QUAT(2)  , QUATD(2)  , T , 16 )
         CALL spINTEG ( QUAT(3)  , QUATD(3)  , T , 17 )
         CALL spINTEG ( QUAT(4)  , QUATD(4)  , T , 18 )

C        SAVE TIME OF LAST MISSILE STATE UPDATE

         TLMSU  = T

      ENDIF


C-------------------------------------------------------------------C
C---------------------------- SEPARATION MODULE ----------------------C
C-------------------------------------------------------------------C
C                              Models discontinuities occuring during C
C                              stage separation                     C
C                                                                   C
C-------------------------------------------------------------------C



C        NOSE FAIRING / BOOST ADAPTER SEPARATION
```

```
          IF ( IDROP.EQ.1 .OR. (ABS(T-TDROP).LE.DTEPS
     *                .AND. IGIT.EQ.1 ) ) THEN
             WKV    = WKV - WBANF
             MASS   = WKV/XMTOF
             WRITE(MESSAGE,155) T
             CALL OUTMES(MESSAGE)
155          FORMAT(1X,E16.9,' DROP NOSE FAIRING AND BOOST ADAPTER')

C            REINITIALIZE PERTINENT INTEGRALS

             CALL spINTEGI ( MASS   , 0.0e0 , T   1 )
             CALL spINTEGI ( WPROP  , 0.0e0 , T , 2 )
             CALL spINTEGI ( IMPULS , 0.0e0 , T , 3 )
             CALL spINTEGI ( WKV    , 0.0e0 , T , 5 )
           ENDIF

C-------------------------------------------------------------------------C
C---------------------- Processor communication --------------------------C
C-------------------------------------------------------------------------C

c      call switch_timing()

C---------  Communicate with p01  -----------C

       CALL SEND_REAL_32BIT( IXX )
       CALL SEND_REAL_32BIT( IYY )
       CALL SEND_REAL_32BIT( IZZ )
       CALL SEND_REAL_32BIT( MASS )

C-------------  Communicate with p03 --------------------------------C

       CALL SEND_REAL_32BIT( P )
       CALL SEND_REAL_32BIT( Q )
       CALL SEND_REAL_32BIT( R )
c      CALL RECEIVE_REAL_64BIT( d_XD )
c      XD = d_XD
c      CALL RECEIVE_REAL_64BIT( d_YD )
c      YD = d_YD
c      CALL RECEIVE_REAL_64BIT( d_ZD )
c      ZD = d_ZD
       CALL RECEIVE_REAL_32BIT( XD )
       CALL RECEIVE_REAL_32BIT( YD )
       CALL RECEIVE_REAL_32BIT( ZD )
       CALL SEND_REAL_32BIT( CIM(1) )
       CALL SEND_REAL_32BIT( CIM(2) )
       CALL SEND_REAL_32BIT( CIM(3) )
       CALL SEND_REAL_32BIT( CIM(4) )
       CALL SEND_REAL_32BIT( CIM(5) )
       CALL SEND_REAL_32BIT( CIM(6) )
       CALL SEND_REAL_32BIT( CIM(7) )
       CALL SEND_REAL_32BIT( CIM(8) )
       CALL SEND_REAL_32BIT( CIM(9) )

C---------  Communicate with p01  -----------C

       CALL RECEIVE_SIGNED_16BIT( IDROP )

C---------  Receive from ACSTHR and VCSTHR  -----------C

       CALL receive_REAL_32BIT( mdotV )
       CALL receive_REAL_32BIT( mdota )
       CALL receive_REAL_32BIT( mxvcs )
       CALL receive_REAL_32BIT( myvcs )
```

```
      CALL receive_REAL_32BIT( mzvcs )
      CALL receive_REAL_32BIT( mxacs )
      CALL receive_REAL_32BIT( myacs )
      CALL receive_REAL_32BIT( mzacs )

      CALL SEND_REAL_32BIT( PD )
      CALL SEND_REAL_32BIT( QD )
      CALL SEND_REAL_32BIT( RD )

c     call switch_timing()

C-------------------------------------------------------------------------C
C------------------------- OUTPUT MODULE ---------------------------------C
C-------------------------------------------------------------------------C
C                             Creates print and plot output data        C
C                             files                                     C
C                                                                       C
C-------------------------------------------------------------------------C
c     call stop_timing()

c     if (  mod(int(tstep),int(dtprt)).eq.0 ) then
c        call output_timing()
c        call initialize_timing()
c     ENDIF

C-------------------------------------------------------------------------C
C------------------------- TERMINATION LOGIC -----------------------------C
C-------------------------------------------------------------------------C
C                             Defines the simulation termination        C
C                             conditions                                C
C                                                                       C
C-------------------------------------------------------------------------C

C     INITIALIZE SIMULATION EXIT FLAG TO ZERO ( PREVENTS EXIT )

      IEXIT  = 0

C     ENABLE EXIT IF MAXIMUM SIMULATION TIME HAS BEEN EXECUTED AND ALL
C     EVENTS SCHEDULED FOR THIS TIME HAVE BEEN EXECUTED

      IF ( T.GE.TFINAL ) THEN
         IEXIT  = 1
      ENDIF

C     increment time

      TSTEP = TSTEP + 1.0e0
      T = TSTEP * DELT

C     CONTINUE LOOPING UNTIL ONE OR MORE EXIT CONDITIONS HAVE BEEN MET

      IF ( IEXIT.EQ.0 ) GO TO 1000


      CALL OUTMES('ERROR: Exit from P00')
      END
```

## B.1.2 Uup01.for

```
c      PROGRAM EXOSIM
C-------------------------------------------------------------------------C
C--------------- Declare and initialize variables  ---------------------C
C-------------------------------------------------------------------------C

      IMPLICIT DOUBLE PRECISION         (A-H)
      IMPLICIT DOUBLE PRECISION         (O-Z)

      CHARACTER*128 MESSAGE
C     THE FOLLOWING COMMON BLOCKS USED FOR MIDFLIGHT CAPABILITIES ONLY

      COMMON / ROBTRG / FIRST2 , TL2    , GRTPST
      COMMON / RNAVIG / GRLAST , T0NAV  , MNAV   , DTX0   , DTY0  ,
     .                  DTZ0

      DOUBLE PRECISION TSTEP,DELT
      DOUBLE PRECISION TIMUDRIV,TGPUDRIV
      DOUBLE PRECISION TIMUSTEP,TGPUSTEP

      DOUBLE PRECISION  GRLAST(3)    ,  GRTPST(3)
      DOUBLE PRECISION  VTIC(5,3)    ,  rtic(5,3)
      DOUBLE PRECISION  GRT(5,3),GRTEST(3),RTEST(3),VTEST(3)
      DOUBLE PRECISION  RREL(3),VREL(3)

      INTEGER           FIRST1       ,  FIRST2
      INTEGER SEKTYP


C     OUTPUTS

      DOUBLE PRECISION  MASS
      DOUBLE PRECISION  TI2M(9)
      DOUBLE PRECISION  QS1(4)       ,  VMI(3)       ,  RMI(3)
      DOUBLE PRECISION  VMIR(3)
      DOUBLE PRECISION  AT(3)
      DOUBLE PRECISION  GR(3)        ,  CIE(9)

C     NAMELIST INPUTS

      DOUBLE PRECISION  XYZE(3)      ,  XYZED(3)
      DOUBLE PRECISION  PULSEG(3)
      DOUBLE PRECISION  PULSEA(3)

      DOUBLE PRECISION   LATLP,LONGLP
      DOUBLE PRECISION   RMIR(3)

      real s_mass,s_pulsea(3),s_pulseg(3)
      real S_XD,S_YD,S_ZD,S_GR(3)

* DATA INITIALIZATION
$INCLUDE('^/INCLUDE/SSDATA35.DAT')
$INCLUDE('^/INCLUDE/SSDATA38.DAT')
$INCLUDE('^/INCLUDE/SSDATA39.DAT')
$INCLUDE('^/INCLUDE/SSDATA42.DAT')
$INCLUDE('^/INCLUDE/SSDATA44.DAT')
$INCLUDE('^/INCLUDE/SSDATA45.DAT')
$INCLUDE('^/INCLUDE/SSDATA46.DAT')
$INCLUDE('^/INCLUDE/SSDATA47.DAT')
$INCLUDE('^/INCLUDE/SSDATA48.DAT')
$INCLUDE('^/INCLUDE/SSDATA49.DAT')
$INCLUDE('^/INCLUDE/SSDATA50.DAT')
```

```
$INCLUDE('^/INCLUDE/SSDATA01.DAT')
$INCLUDE('^/INCLUDE/SSDATA17.DAT')
$INCLUDE('^/INCLUDE/SSDATA18.DAT')
$INCLUDE('^/INCLUDE/SSDATA21.DAT')
$INCLUDE('^/INCLUDE/SSDATA22.DAT')
$INCLUDE('^/INCLUDE/SSDATA23.DAT')
$INCLUDE('^/INCLUDE/SSDATA28.DAT')
$INCLUDE('^/INCLUDE/SSDATA29.DAT')
$INCLUDE('^/INCLUDE/SSDATA30.DAT')
$INCLUDE('^/INCLUDE/SSDATA71.DAT')
$INCLUDE('^/INCLUDE/SSTIMING.DAT')
$INCLUDE('SSp01.DAT')

* INITIALIZE 80x87
      CALL CW87


C-------------------------------------------------------------------------C
C---------------------------- MAIN EXECUTION LOOP ------------------------C
C-------------------------------------------------------------------------C
C                               Execution of all events is performed    C
C                               within this loop                        C
C                                                                       C
C-------------------------------------------------------------------------C


 1000 CONTINUE

C     WRITE(*,*)'--------------BEGINNING OF LOOP-----------------'

C-------------------------------------------------------------------------C
C----------------------- Processor communication -------------------------C
C-------------------------------------------------------------------------C


C----------------------- COMMUNICATION WITH P00 --------------------------C

      CALL RECEIVE_REAL_32BIT( S_GR(01) )
      CALL RECEIVE_REAL_32BIT( S_GR(02) )
      CALL RECEIVE_REAL_32BIT( S_GR(03) )
      GR(1) = S_GR(1)
      GR(2) = S_GR(2)
      GR(3) = S_GR(3)
      CALL RECEIVE_REAL_32BIT( s_MASS )
      MASS = s_MASS
      CALL RECEIVE_REAL_32BIT( s_PULSEA(01) )
      PULSEA(01) = s_PULSEA(01)
      CALL RECEIVE_REAL_32BIT( s_PULSEA(02) )
      PULSEA(02) = s_PULSEA(02)
      CALL RECEIVE_REAL_32BIT( s_PULSEA(03) )
      PULSEA(03) = s_PULSEA(03)
      CALL RECEIVE_REAL_32BIT( s_PULSEG(01) )
      PULSEG(01) = s_PULSEG(01)
      CALL RECEIVE_REAL_32BIT( s_PULSEG(02) )
      PULSEG(02) = s_PULSEG(02)
      CALL RECEIVE_REAL_32BIT( s_PULSEG(03) )
      PULSEG(03) = s_PULSEG(03)
      CALL RECEIVE_REAL_64BIT( XYZE(01) )
      CALL RECEIVE_REAL_64BIT( XYZE(02) )
      CALL RECEIVE_REAL_64BIT( XYZE(03) )
      CALL RECEIVE_REAL_64BIT( XYZED(01) )
      CALL RECEIVE_REAL_64BIT( XYZED(02) )
      CALL RECEIVE_REAL_64BIT( XYZED(03) )
```

```
C----------------------- COMMUNICATION WITH SEEKER --------------------C

      CALL RECEIVE_REAL_64BIT( X )
      CALL RECEIVE_REAL_64BIT( Y )
      CALL RECEIVE_REAL_64BIT( Z )
      CALL RECEIVE_REAL_32BIT( S_XD )
      CALL RECEIVE_REAL_32BIT( S_YD )
      CALL RECEIVE_REAL_32BIT( S_ZD )
      XD = S_XD
      YD = S_YD
      ZD = S_ZD

C----------------------- COMMUNICATION WITH CORVEL --------------------C

      CALL SEND_REAL_32BIT( sngl(RMIR(1) ))
      CALL SEND_REAL_32BIT( sngl(RMIR(2) ))
      CALL SEND_REAL_32BIT( sngl(RMIR(3) ))
      CALL SEND_REAL_32BIT( sngl(VMIR(1) ))
      CALL SEND_REAL_32BIT( sngl(VMIR(2) ))
      CALL SEND_REAL_32BIT( sngl(VMIR(3) ))

      CALL RECEIVE_REAL_64BIT( GRT(01,01) )
      CALL RECEIVE_REAL_64BIT( GRT(01,02) )
      CALL RECEIVE_REAL_64BIT( GRT(01,03) )
      CALL RECEIVE_REAL_64BIT( RTIC(01,01) )
      CALL RECEIVE_REAL_64BIT( RTIC(01,02) )
      CALL RECEIVE_REAL_64BIT( RTIC(01,03) )
      CALL RECEIVE_REAL_64BIT( VTIC(01,01) )
      CALL RECEIVE_REAL_64BIT( VTIC(01,02) )
      CALL RECEIVE_REAL_64BIT( VTIC(01,03) )

C---------------- COMMUNICATE WITH CORVEL --------------C

      CALL SEND_REAL_32BIT( sngl(AT(01) ))
      CALL SEND_REAL_32BIT( sngl(AT(02) ))
      CALL SEND_REAL_32BIT( sngl(AT(03) ))

C---------------- DAISY CHAIN  -------------------C

      CALL SEND_REAL_32BIT( SNGL(TI2M(1)) )
      CALL SEND_REAL_32BIT( SNGL(TI2M(2)) )
      CALL SEND_REAL_32BIT( SNGL(TI2M(3)) )
      CALL SEND_REAL_32BIT( SNGL(TI2M(4)) )
      CALL SEND_REAL_32BIT( SNGL(TI2M(5)) )
      CALL SEND_REAL_32BIT( SNGL(TI2M(6)) )
      CALL SEND_REAL_32BIT( SNGL(TI2M(7)) )
      CALL SEND_REAL_32BIT( SNGL(TI2M(8)) )
      CALL SEND_REAL_32BIT( SNGL(TI2M(9)) )

      CALL SEND_REAL_32BIT( SNGL(VREL(1)) )
      CALL SEND_REAL_32BIT( SNGL(VREL(2)) )
      CALL SEND_REAL_32BIT( SNGL(VREL(3)) )
      CALL SEND_REAL_32BIT( SNGL(RREL(1)) )
      CALL SEND_REAL_32BIT( SNGL(RREL(2)) )
      CALL SEND_REAL_32BIT( SNGL(RREL(3)) )

      CALL SEND_REAL_32BIT( SNGL(SP) )
      CALL SEND_REAL_32BIT( SNGL(SQ) )
      CALL SEND_REAL_32BIT( SNGL(SR) )


C-----------------------------------------------------------------------C
C---------------------------- INERTIAL MEASUREMENT UPDATE ------------C
C-----------------------------------------------------------------------C
```

```
C                              Get inertial measurement data needed    C
C                              for guidance calculations .             C
C                                                                      C
C----------------------------------------------------------------------C

      IF ( TSTEP .GE. TIMUDRIV ) THEN

         TIMUDRIV = TIMUDRIV + TIMUSTEP

C----------------------------------------------------------------------C
C----------------------------- IMU PROCESSOR MODULE -------------------C
C----------------------------------------------------------------------C
C                              Convert gyro and accelerometer outputs  C
C                              to delta angle and delta velocity       C
C                                                                      C
C----------------------------------------------------------------------C

         CALL IMUPRO(T,PULSEG,PULSEA,DELPHI,DELTHT,DELPSI,
     .               DELU,DELV,DELW)

C----------------------------------------------------------------------C
C----------------------------- NAVIGATION MODULE ----------------------C
C----------------------------- ----------------------------------------C
C                              This module calculates the quaternions  C
C                              and transformation matrices using delta C
C                              angles sensed by the gyro and calculatesC
C                              the interceptor velocity and position   C
C                              using delta velocity sensed by the      C
C                              accelerometer                           C
C                                                                      C
C----------------------------------------------------------------------C

         CALL NAVIG(T,MASS,DELPHI,DELTHT,DELPSI,DELU,DELV,DELW,GR,
     .           QS1,CIE,SP,SQ,SR,SUD,SVD,SWD,VMIR,RMIR,TI2M,SPHI,STHT,
     .               SPSI,SU,SV,SW,AT,VMI,RMI)

      ENDIF

C----------------------------------------------------------------------C
C----------------------------- MIDCOURSE CORRECTION -------------------C
C----------------------------------------------------------------------C
C                              Models uplink of interceptor,           C
C                              target, and intercept conditions        C
C                                                                      C
C----------------------------------------------------------------------C

      IF ( ( DABS(T-TUPLK1).LE.DTEPS ) .OR.
     *     ( DABS(T-TUPLK2).LE.DTEPS ) ) THEN

C        REVISE ESTIMATED MISSILE STATES

         VMI(1)     = XYZED(1)
         VMI(2)     = XYZED(2)
         VMI(3)     = XYZED(3)

         RMI(1)     = XYZE(1)
         RMI(2)     = XYZE(2)
         RMI(3)     = XYZE(3)
```

```
         VMIR(1)    = XD
         VMIR(2)    = YD
         VMIR(3)    = ZD

         RMIR(1)    = X
         RMIR(2)    = Y
         RMIR(3)    = Z

         TONAV      = T

      ENDIF

C-------------------------------------------------------------------------C
C------------------------------ MIDCOURSE CORRECTION ---------------------C
C-------------------------------------------------------------------------C
C                               Models uplink of interceptor,             C
C                               target, and intercept conditions          C
C                                                                         C
C-------------------------------------------------------------------------C


      IF ( ( DABS(T-TUPLK1).LE.DTEPS ) .OR.
     *     ( DABS(T-TUPLK2).LE.DTEPS ) ) THEN

C        REVISE ESTIMATED TARGET STATES

         RTEST(1)   = RTIC(1,1)
         RTEST(2)   = RTIC(1,2)
         RTEST(3)   = RTIC(1,3)

         VTEST(1)   = VTIC(1,1)
         VTEST(2)   = VTIC(1,2)
         VTEST(3)   = VTIC(1,3)

         GRTEST(1)  = GRT(1,1)
         GRTEST(2)  = GRT(1,2)
         GRTEST(3)  = GRT(1,3)

         TL2        = T

      ENDIF


C-------------------------------------------------------------------------C
C                             ON BOARD GUIDANCE PROCESSING                C
C-------------------------------------------------------------------------C
C                             Determine guidance commands                 C
C                                                                         C
C-------------------------------------------------------------------------C


      IF ( TSTEP .GE. TGPUDRIV ) THEN

         TGPUDRIV = TGPUDRIV + TGPUSTEP

C-------------------------------------------------------------------------C
C------------------------------ ON BOARD TARGET MODULE -------------------C
C-------------------------------------------------------------------------C
C                               Estimate target position based on         C
C                               predicted intercept conditions            C
C                                                                         C
C-------------------------------------------------------------------------C
```

```
C        GRTEST TEMPORARILY EQUAL TO GRT

         GRTEST(1) = GRT(1,1)
         GRTEST(2) = GRT(1,2)
         GRTEST(3) = GRT(1,3)

         CALL OBTARG(T,GRTEST,RTEST,VTEST)
         CALL ESTREL2(RTEST,VTEST,RMIR,VMIR,RREL,VREL)

      ENDIF

C-------------------------------------------------------------------------C
C----------------------------- TERMINATION LOGIC -------------------------C
C-------------------------------------------------------------------------C
C                              Defines the simulation termination         C
C                              conditions                                 C
C                                                                         C
C-------------------------------------------------------------------------C

C     INITIALIZE SIMULATION EXIT FLAG TO ZERO ( PREVENTS EXIT )

      IEXIT  = 0

C     ENABLE EXIT IF MAXIMUM SIMULATION TIME HAS BEEN EXECUTED AND ALL
C     EVENTS SCHEDULED FOR THIS TIME HAVE BEEN EXECUTED

      IF ( T.GE.TFINAL ) THEN
         IEXIT  = 1
      ENDIF

C     increment time

      TSTEP = TSTEP + 1.0D0
      T = TSTEP * DELT

C     CONTINUE LOOPING UNTIL ONE OR MORE EXIT CONDITIONS HAVE BEEN MET

      IF ( IEXIT.EQ.0 ) GO TO 1000

      END
```

### B.1.3 Uup02.for

```
c      PROGRAM EXOSIM
C-------------------------------------------------------------------------C
C--------------- Declare and initialize variables  ---------------------C
C-------------------------------------------------------------------------C

      IMPLICIT REAL          (A-H)
      IMPLICIT REAL          (O-Z)

      CHARACTER*128 MESSAGE

C     THE FOLLOWING COMMON BLOCK USED FOR MIDFLIGHT CAPABILITIES ONLY

      COMMON / RVCSTR / TREFLV , TLSTV  , TMVCS  , THVCS  , LENVCS

      REAL  TMVCS(6,4)    ,  THVCS(6,4)    ,  DTOFFV(4)
      REAL  CG(3)
      REAL  TOFFLT(4)
      REAL  FOFF1(4)      ,  FOFF2(4)
      REAL  MXVCS         ,  MYVCS         ,  MZVCS
      REAL  MDOTV ,latlp,longlp

      INTEGER           LENVCS(4)
      INTEGER           SEKTYP

      REAL TSTEP,DELT
      REAL TMSUDRIV,TMSUSTEP

      double precision  d_DTOFFV(4)
      double precision  d_CG(3)
      double precision  d_TOFFLT(4),d_tvtab
      double precision  d_MXVCS         ,  d_MYVCS         ,  d_MZVCS
      double precision  d_FXVCS         ,  d_FYVCS         ,  d_FZVCS
      double precision  d_MDOTV ,d_tburnm,d_timonv

* DATA INITIALIZATION
$INCLUDE('^/INCLUDE/SSDATA35.DAT')
$INCLUDE('^/INCLUDE/SSDATA38.DAT')
$INCLUDE('^/INCLUDE/SSDATA39.DAT')
$INCLUDE('^/INCLUDE/SSDATA42.DAT')
$INCLUDE('^/INCLUDE/SSDATA44.DAT')
$INCLUDE('^/INCLUDE/SSDATA45.DAT')
$INCLUDE('^/INCLUDE/SSDATA46.DAT')
$INCLUDE('^/INCLUDE/SSDATA47.DAT')
$INCLUDE('^/INCLUDE/SSDATA48.DAT')
$INCLUDE('^/INCLUDE/SSDATA49.DAT')
$INCLUDE('^/INCLUDE/SSDATA50.DAT')
$INCLUDE('^/INCLUDE/SSDATA01.DAT')
$INCLUDE('^/INCLUDE/SSDATA17.DAT')
$INCLUDE('^/INCLUDE/SSDATA18.DAT')
$INCLUDE('^/INCLUDE/SSDATA21.DAT')
$INCLUDE('^/INCLUDE/SSDATA22.DAT')
$INCLUDE('^/INCLUDE/SSDATA23.DAT')
$INCLUDE('^/INCLUDE/SSDATA28.DAT')
$INCLUDE('^/INCLUDE/SSDATA29.DAT')
$INCLUDE('^/INCLUDE/SSDATA30.DAT')
$INCLUDE('^/INCLUDE/SSDATA71.DAT')
$INCLUDE('^/INCLUDE/SSTIMING.DAT')
$INCLUDE('SSp02.DAT')

* INITIALIZE 80x87
      CALL CW87
```

```
C-------------------------------------------------------------------------C
C---------------------------- MAIN EXECUTION LOOP -----------------------C
C-------------------------------------------------------------------------C
C                              Execution of all events is performed     C
C                              within this loop                         C
C                                                                       C
C-------------------------------------------------------------------------C


 1000 CONTINUE


C     WRITE(*,*)'--------------BEGINNING OF LOOP-----------------'

C-------------------------------------------------------------------------C
C--------------------------- MISSILE STATE UPDATE MODULE ----------------C
C-------------------------------------------------------------------------C
C                             Integrate missile states to current time  C
C                                                                       C
C-------------------------------------------------------------------------C

C--------- recieve from masspr (P00) ----------C

      CALL RECEIVE_REAL_32BIT( cg(01) )
      CALL RECEIVE_REAL_32BIT( cg(02) )
      CALL RECEIVE_REAL_32BIT( cg(03) )

C--------- Send variables to masspr and missil (p00) ------------------C

      CALL send_REAL_32BIT( mdotV )

      CALL send_REAL_32BIT( fxvcs )
      CALL send_REAL_32BIT( fyvcs )
      CALL send_REAL_32BIT( fzvcs )

      CALL send_REAL_32BIT( mxvcs )
      CALL send_REAL_32BIT( myvcs )
      CALL send_REAL_32BIT( mzvcs )


C---------- Communication with p01 -----------------C
      CALL RECEIVE_REAL_32BIT( DTOFFV(01) )
      CALL RECEIVE_REAL_32BIT( DTOFFV(02) )
      CALL RECEIVE_REAL_32BIT( DTOFFV(03) )
      CALL RECEIVE_REAL_32BIT( DTOFFV(04) )
      CALL RECEIVE_SIGNED_16BIT( IVCS )
      CALL RECEIVE_SIGNED_16BIT( IVTAB )
      CALL RECEIVE_REAL_32BIT( TBURNM )
      CALL RECEIVE_REAL_32BIT( TIMONV )
      CALL RECEIVE_REAL_32BIT( TOFFLT(01) )
      CALL RECEIVE_REAL_32BIT( TOFFLT(02) )
      CALL RECEIVE_REAL_32BIT( TOFFLT(03) )
      CALL RECEIVE_REAL_32BIT( TOFFLT(04) )
      CALL RECEIVE_REAL_32BIT( TVTAB )

      IF ( tstep .gE. tmsudriv ) THEN

         tmsudriv = tmsudriv + tmsustep


C-------------------------------------------------------------------------C
C---------------------------- VCS THRUSTER RESPONSE MODULE ---------------C
C-------------------------------------------------------------------------C
```

```
C                              Determines the forces and moments       C
C                              imparted by the VCS thrusters           C
C                                                                      C
C----------------------------------------------------------------------C

         IF ( T.GE.TKVON ) THEN

            CALL VCSTHR(T,CG,TBURNM,IVCS,TOFFLT,
     .                  timonv,DTOFFV,TVTAB,FOFF1,FOFF2,IVTAB,TBRK,
     .                  FXVCS,FYVCS,FZVCS,MXVCS,MYVCS,MZVCS,MDOTV)

            ENDIF

         ENDIF


C----------------------------------------------------------------------C
C---------------------------- TERMINATION LOGIC -----------------------C
C----------------------------------------------------------------------C
C                              Defines the simulation termination      C
C                              conditions                              C
C                                                                      C
C----------------------------------------------------------------------C

C        INITIALIZE SIMULATION EXIT FLAG TO ZERO ( PREVENTS EXIT )

         IEXIT  = 0

C        increment time

         TSTEP = TSTEP + 1.0e0
         T = TSTEP * DELT

C        CONTINUE LOOPING UNTIL ONE OR MORE EXIT CONDITIONS HAVE BEEN MET

         IF ( IEXIT.EQ.0 ) GO TO 1000

         END
```

## B.1.4 Uup03.for

```
C       PROGRAM EXOSIM
C-----------------------------------------------------------------------C
C--------------- Declare and initialize variables  --------------------C
C-----------------------------------------------------------------------C


      IMPLICIT DOUBLE PRECISION          (A-H)
      IMPLICIT DOUBLE PRECISION          (O-Z)

      CHARACTER*128 MESSAGE
C     THE FOLLOWING COMMON BLOCKS USED FOR MIDFLIGHT CAPABILITIES ONLY

      COMMON / PTARG  / TL1     , GRTLST , FIRST1

      REAL CER(9),CIM(9),Q,R,ZD,YD,XD,PTARG,QTARG,RTARG
      REAL TPHI,TTHT,TPSI,TPHID,TTHTD,TPSID,CIT(9),CTI(9)

      DOUBLE PRECISION  XINT(50)      ,  TINT(50)      ,  XDOTL(50)
      DOUBLE PRECISION  SF1G(3)       ,  SF2G(3)       ,  DCG(3)
      DOUBLE PRECISION  SF1A(3)       ,  SF2A(3)       ,  DCA(3)
      DOUBLE PRECISION  OMEGA0(3)     ,  XYZLCH(3)     ,  EVTIME(20)
      DOUBLE PRECISION  MASSL         ,  MACHL         ,  ANGACL(3,4,10)
      DOUBLE PRECISION  OMEGAI(3)     ,  GRTLST(5,3)   ,  CIMO(9)
      DOUBLE PRECISION  WBI2(3)       ,  WBI1(3)       ,  WBO2(3)
      DOUBLE PRECISION  WBO1(3)       ,  GRLST(3)      ,  XYZDP(3)
      DOUBLE PRECISION  ABI2(3)       ,  ABI1(3)       ,  ABO2(3)
      DOUBLE PRECISION  ABO1(3)       ,  GRLAST(3)     ,  GRTPST(3)
      DOUBLE PRECISION  TLATCH(10)    ,  LAMMSV(2,10)  ,  RRELSV(3,10)
      DOUBLE PRECISION  VRELSV(3,10)  ,  TI2MSV(9,10)  ,  SNRSV(10)
      DOUBLE PRECISION  AACCEL(3,4)

      DOUBLE PRECISION  CGX(20)       ,  CGY(20)       ,  CGZ(20)
      DOUBLE PRECISION  MASST1(20)    ,  MASST2(20)

      REAL              RANSEQ(97)    ,  RANLST        ,  RAND1(98)

      INTEGER           IEVFLG(20)    ,  FIRST1        ,  FIRST2
      INTEGER           ISEQ(4)       ,  IMCPAS(3,4)   ,  FLIP
      INTEGER           VCOD(4)       ,  GATE

C     OUTPUTS

      DOUBLE PRECISION  MXA           ,  MYA           ,  MZA
      DOUBLE PRECISION  MXT           ,  MYT           ,  MZT
      DOUBLE PRECISION  MRCX          ,  MRCY          ,  MRCZ
      DOUBLE PRECISION  MXVCS         ,  MYVCS         ,  MZVCS
      DOUBLE PRECISION  MXACS         ,  MYACS         ,  MZACS
      DOUBLE PRECISION  MX            ,  MY            ,  MZ
      DOUBLE PRECISION  MACH          ,  MDOTT         ,  MDOTF
      DOUBLE PRECISION  MDOTV         ,  MDOTA         ,  LFRACS
      DOUBLE PRECISION  KN            ,  KM            ,  MDLTFR
      DOUBLE PRECISION  KTHT          ,  KTHTD         ,  MDELTA
      DOUBLE PRECISION  KNE           ,  KME           ,  MALPHA
      DOUBLE PRECISION  LATT          ,  LONGT         ,  MVS
      DOUBLE PRECISION  KA            ,  KV            ,  MAGRTR
      DOUBLE PRECISION  MAGLOS        ,  MGRDTR        ,  MAGR
      DOUBLE PRECISION  MAGV          ,  MGRDOT        ,  MXYZDD
      DOUBLE PRECISION  MGR           ,  LAT           ,  LONG
      DOUBLE PRECISION  MISS          ,  MVR           ,  MVRWM
      DOUBLE PRECISION  ATHRF(4)      ,  CMMD(2)       ,  VCMDL(4)
      DOUBLE PRECISION  PTER(3)       ,  CMS(9)
```

```
      DOUBLE PRECISION  GRT(5,3)      ,  ADISTT(4,3)
      DOUBLE PRECISION  RTAR(3)       ,  VTAR(3)       ,  UVS(3)
      DOUBLE PRECISION  VC(3)         ,  DLV(3)        ,  VTTP(3)
      DOUBLE PRECISION  VS(3)         ,  US(3)         ,  AC(3)
      DOUBLE PRECISION  CIR(9)        ,  CMI(9)
      DOUBLE PRECISION  VW(3)         ,  WC(3)         ,  PM(3)
      DOUBLE PRECISION  CGEST(3)      ,  RRELTR(3)     ,  VRELTP(3)
      DOUBLE PRECISION  LAMTRU(2)     ,  LAMDXX(2)     ,  LAMDTR(2)
      DOUBLE PRECISION  LAMSEK(2)     ,  LAMDSK(2)     ,  LAMM(2)
      DOUBLE PRECISION  RTEST(3)      ,  RREL(3)       ,  URREL(3)
      DOUBLE PRECISION  VREL(3)       ,  TI2M(9)       ,  USI(3)
      DOUBLE PRECISION  QS1(4)        ,  VMI(3)        ,  RMI(3)
      DOUBLE PRECISION  VMIR(3)       ,  RMIR(3)       ,  VTEST(3)
      DOUBLE PRECISION  AT(3)         ,  XYZR(3)       ,  GB(3)
      DOUBLE PRECISION  GR(3)         ,  CRI(9)
      DOUBLE PRECISION  VRWM(3)       ,  CEI(9)        ,  CIE(9)
      DOUBLE PRECISION  PG(3)         ,  VTT(3)        ,  USO(3)
      DOUBLE PRECISION  PG0(3)        ,  USF(3)        ,  QUATIC(4)
      DOUBLE PRECISION  TI2MO(9)      ,  GREST(3)
      DOUBLE PRECISION  LAMMO(2)      ,  RRELO(3)      ,  VRELO(3)
      DOUBLE PRECISION  RRELM(3)      ,  VRELM(3)      ,  GRTEST(3)
      DOUBLE PRECISION  FOFF1(4)      ,  FOFF2(4)

C     NAMELIST INPUTS

      DOUBLE PRECISION  IXX           ,  IYY           ,  IZZ
      DOUBLE PRECISION  CG(3)         ,  MASS          ,  PQR(3)
      DOUBLE PRECISION  IMPULS        ,  QUAT(4)       ,  MDOT
      DOUBLE PRECISION  QUATD(4)      ,  BOFF2(2)      ,  TMVCS(6,4)
      DOUBLE PRECISION  THVCS(6,4)    ,  DTOFFV(4)     ,  VG(3)
      DOUBLE PRECISION  TMACSA(8,4)   ,  THACSA(8,4)   ,  DTACSA(4)
      DOUBLE PRECISION  TMACSB(8,4)   ,  THACSB(8,4)   ,  DTACSB(4)
      DOUBLE PRECISION  XYZE(3)       ,  XYZED(3)      ,  RTIC(5,3)
      DOUBLE PRECISION  VTIC(5,3)     ,  PULSEG(3)     ,  QFRACG(3)
      DOUBLE PRECISION  PULSEA(3)     ,  QFRACA(3)     ,  XYZEDD(3)
      DOUBLE PRECISION  LAM(2)        ,  LAMD(2)       ,  VGM(3)
      DOUBLE PRECISION  DTVCSP(3)     ,  DTVCSY(3)     ,  FLTC(4)
      DOUBLE PRECISION  TOFFLT(4)     ,  TMF(8,4)      ,  THF(8,4)
      DOUBLE PRECISION  DTOFF(4)      ,  VWIC(3)       ,  AOFF1(4)
      DOUBLE PRECISION  VTTIC(3)      ,  USD(3)        ,  VCMD(4)
      DOUBLE PRECISION  PGD(3)        ,  VWD(3)        ,  MASS0
      DOUBLE PRECISION  MSSTG2        ,  LATLP         ,  LONGLP
      DOUBLE PRECISION  IMPLS0        ,  MVRDOT
      DOUBLE PRECISION  RJ(5)
      DOUBLE PRECISION  AOFF2(4)

      INTEGER           LENVCS(4)     ,  LENA(4)       ,  LENB(4)
      INTEGER           LENF(4)       ,  GYSEED        ,  FRMCNT
      INTEGER           SKSEED        ,  SEKTYP        ,  ACQD
      INTEGER           TERM          ,  TOSEED        ,  VLVCM5
      INTEGER           ESTATE
      INTEGER           TRACK
      INTEGER           ROWBEG        ,  COLBEG        ,  PLOTNO

       DOUBLE PRECISION TSTEP,DELT
       DOUBLE PRECISION TMSUDRIV,TTSUDRIV,TRSUDRIV,TIMUDRIV,
     *                  TGPUDRIV,TAPUDRIV,TSPUDRIV,TKFUDRIV
       DOUBLE PRECISION TMSUSTEP,TTSUSTEP,TRSUSTEP,TIMUSTEP,
     *                  TGPUSTEP,TAPUSTEP,TSPUSTEP,TKFUSTEP
       Integer irst,jrst,krst

* DATA INITIALIZATION
$INCLUDE('^/INCLUDE/SSDATA35.DAT')
$INCLUDE('^/INCLUDE/SSDATA38.DAT')
```

```
$INCLUDE('^/INCLUDE/SSDATA39.DAT')
$INCLUDE('^/INCLUDE/SSDATA42.DAT')
$INCLUDE('^/INCLUDE/SSDATA44.DAT')
$INCLUDE('^/INCLUDE/SSDATA45.DAT')
$INCLUDE('^/INCLUDE/SSDATA46.DAT')
$INCLUDE('^/INCLUDE/SSDATA47.DAT')
$INCLUDE('^/INCLUDE/SSDATA48.DAT')
$INCLUDE('^/INCLUDE/SSDATA49.DAT')
$INCLUDE('^/INCLUDE/SSDATA50.DAT')
$INCLUDE('^/INCLUDE/SSDATA01.DAT')
$INCLUDE('^/INCLUDE/SSDATA17.DAT')
$INCLUDE('^/INCLUDE/SSDATA18.DAT')
$INCLUDE('^/INCLUDE/SSDATA21.DAT')
$INCLUDE('^/INCLUDE/SSDATA22.DAT')
$INCLUDE('^/INCLUDE/SSDATA23.DAT')
$INCLUDE('^/INCLUDE/SSDATA28.DAT')
$INCLUDE('^/INCLUDE/SSDATA29.DAT')
$INCLUDE('^/INCLUDE/SSDATA30.DAT')
$INCLUDE('^/INCLUDE/SSDATA71.DAT')
$INCLUDE('^/INCLUDE/SSTIMING.DAT')

$INCLUDE('^/INCLUDE/SSMAS_cg.DAT')

      DATA IMASS  , IAERO  ,  IBTHR  ,  IBAUTO  /  1 , 1 , 1 , 1 /

* INITIALIZE 80x87
      CALL CW87

$INCLUDE('SSp03.DAT')


C-------------------------------------------------------------------------C
C----------------------------- MAIN EXECUTION LOOP -----------------------C
C-------------------------------------------------------------------------C
C                               Execution of all events is performed    C
C                               within this loop                        C
C                                                                       C
C-------------------------------------------------------------------------C


 1000 CONTINUE

C-------------------------------------------------------------------------C
C------------------------ Processor communication ------------------------C
C-------------------------------------------------------------------------C

C-------------  Communicate with p00 -------------------------------C

      CALL RECEIVE_REAL_32BIT( Q )
      CALL RECEIVE_REAL_32BIT( R )
      CALL RECEIVE_REAL_64BIT( X )
      CALL RECEIVE_REAL_64BIT( Y )
      CALL RECEIVE_REAL_64BIT( Z )
      CALL RECEIVE_REAL_32BIT( XD )
      CALL RECEIVE_REAL_32BIT( YD )
      CALL RECEIVE_REAL_32BIT( ZD )
      CALL RECEIVE_REAL_32BIT( CIM(1) )
      CALL RECEIVE_REAL_32BIT( CIM(2) )
      CALL RECEIVE_REAL_32BIT( CIM(3) )
      CALL RECEIVE_REAL_32BIT( CIM(4) )
      CALL RECEIVE_REAL_32BIT( CIM(5) )
      CALL RECEIVE_REAL_32BIT( CIM(6) )
      CALL RECEIVE_REAL_32BIT( CIM(7) )
      CALL RECEIVE_REAL_32BIT( CIM(8) )
```

```
      CALL RECEIVE_REAL_32BIT( CIM(9) )

C-------------  Communicate with p01 ------ ----------------------------C

      CALL SEND_REAL_64BIT( GRT(01,01) )
      CALL SEND_REAL_64BIT( GRT(01,02) )
      CALL SEND_REAL_64BIT( GRT(01,03) )
      CALL SEND_SIGNED_16BIT( IRESLV )
      CALL SEND_REAL_32BIT( SNGL(LAMDXX(01)) )
      CALL SEND_REAL_32BIT( SNGL(LAMDXX(02)) )
      CALL SEND_REAL_32BIT( SNGL(LAMSEK(01)) )
      CALL SEND_REAL_32BIT( SNGL(LAMSEK(02)) )
      CALL SEND_REAL_32BIT( SNGL(MAGRTR) )
      CALL SEND_REAL_64BIT( RTIC(01,01) )
      CALL SEND_REAL_64BIT( RTIC(01,02) )
      CALL SEND_REAL_64BIT( RTIC(01,03) )
      CALL SEND_REAL_64BIT( VTIC(01,01) )
      CALL SEND_REAL_64BIT( VTIC(01,02) )
      CALL SEND_REAL_64BIT( VTIC(01,03) )

C     WRITE(*,*)'--------------BEGINNING OF LOOP-----------------'

      IF ( tstep .gE. tmsudriv ) THEN

         tmsudriv = tmsudriv + tmsustep

C        ROTATING EARTH MODEL

         CALL SPMMK(0.0E0,1,0.0E0,2,SNGL(OMEGAE*T),3,CER)
      ENDIF

C-------------------------------------------------------------------------C
C----------------------------- RELATIVE STATES MODULE -------------------C
C-------------------------------------------------------------------------C
C                              Calculate relative range, range rate,    C
C                              time-to-go, LOS angles and rates         C
C                                                                       C
C-------------------------------------------------------------------------C


      IF ( TSTEP .GE. TRSUDRIV) THEN

         TRSUDRIV = TRSUDRIV + TRSUSTEP

         CALL RELAT(RTIC,VTIC,X,Y,Z,XD,YD,ZD,Q,R,CIM,CMS,RRELTR,
     .              MAGRTR,VRELTR,MGRDTR,MAGLOS,LAMTRU,LAMDXX,
     .              LAMDTR,LAMSEK,LAMDSK,TGOTR,RRELM,VRELM)

C        EXTRAPOLATE POINT OF CLOSEST APPROACH

         XMISS  = RRELTR(1) + TGOTR*VRELTR(1)
         YMISS  = RRELTR(2) + TGOTR*VRELTR(2)
         ZMISS  = RRELTR(3) + TGOTR*VRELTR(3)

         MISS   = DSQRT ( XMISS**2 + YMISS**2 + ZMISS**2 )

      ENDIF


C-------------------------------------------------------------------------C
C----------------------------- TARGET STATES MODULE ---------------------C
C-------------------------------------------------------------------------C
C                              This module calculates the true exo-     C
C                              atmospheric trajectory data for          C
```

```
C                              the target                                C
C                                                                        C
C------------------------------------------------------------------------C


      IF ( TSTEP .GE. TTSUDRIV ) THEN

         TTSUDRIV = TTSUDRIV + TTSUSTEP

         CALL TARGET( T,MAGRTR,CER,CIE,PTARG,QTARG,RTARG,
     .           TPHI,TTHT,TPSI,GRT,TPHID,TTHTD,TPSID,CIT,RTIC,VTIC,
     .                RTAR,RTER,IRESLV,RJ,CTI,VTAR,LATT,LONGT )


      ENDIF



C------------------------------------------------------------------------C
C---------------------------- TERMINATION LOGIC -------------------------C
C------------------------------------------------------------------------C
C                              Defines the simulation termination        C
C                              conditions                                C
C                                                                        C
C------------------------------------------------------------------------C

C     INITIALIZE SIMULATION EXIT FLAG TO ZERO ( PREVENTS EXIT )

      IEXIT  = 0

C     ENABLE EXIT IF INTERCEPT HAS OCCURRED AND ALL EVENTS SCHEDULED FOR
C     THIS TIME HAVE BEEN EXECUTED

      IF ( TGOTR.LE.TGOMN ) THEN
         IEXIT  = 1
      ENDIF


C     increment time

      TSTEP = TSTEP + 1.0D0
      T = TSTEP * DELT

C     CONTINUE LOOPING UNTIL ONE OR MORE EXIT CONDITIONS HAVE BEEN MET

      IF ( IEXIT.EQ.0 ) GO TO 1000


C------------------------------------------------------------------------C
C---------------------------- POINT OF CLOSEST APPROACH CALCULATION --C
C------------------------------------------------------------------------C
C                              Determines the miss distance at the       C
C                              point of closest approach                 C
C                                                                        C
C------------------------------------------------------------------------C


      MISS   = DSQRT ( (RRELTR(1) + VRELTR(1)*TGOTR)**2
     .               + (RRELTR(2) + VRELTR(2)*TGOTR)**2
     .               + (RRELTR(3) + VRELTR(3)*TGOTR)**2 )

      WRITE(MESSAGE,889) T,MISS
      CALL OUTMES(MESSAGE)
  889 FORMAT(1X,E16.9,' MISS = ',E16.9)
```

END

## B.1.5 Uup04.for

```
C     PROGRAM EXOSIM
C------ ---------------------------------------------------------------C
C--------------- Declare and initialize variables  --------------------C
C-----------------------------------------------------------------------C

      IMPLICIT DOUBLE PRECISION         (A-H)
      IMPLICIT DOUBLE PRECISION         (O-Z)

      CHARACTER*128 MESSAGE
C     THE FOLLOWING COMMON BLOCKS USED FOR MIDFLIGHT CAPABILITIES ONLY

      COMMON / NORCOM / GSET   , ISET
      COMMON / RANCOM / RANSEQ , RANLST
      COMMON / RGYRO  / PSIG   , THTG   , PHIG   , THXZG  , THXYG  ,
     .                  THYZG  , THYXG  , THZYG  , THZXG  , SF1G   ,
     .                  SF2G   , DCG    , T0GYRO , CIMO   , WBI2   ,
     .                  WBI1   , WBO2   , WBO1   , DRSIGG

      REAL S_CIM(9)
      REAL S_P,S_Q,S_R
      DOUBLE PRECISION  SF1G(3)       ,  SF2G(3)       ,  DCG(3)
      REAL              RANSEQ(97)    ,  RANLST
      DOUBLE PRECISION  WBI2(3)       ,  WBI1(3)       ,  WBO2(3)
      DOUBLE PRECISION  WBO1(3)
      DOUBLE PRECISION  CIM(9)
      DOUBLE PRECISION  PULSEG(3)
      DOUBLE PRECISION  QFRACG(3)
      DOUBLE PRECISION  LONGLP, LATLP,  CIMO(9)

      INTEGER*4 GYSEED
      INTEGER   SEKTYP

      DOUBLE PRECISION TSTEP,DELT
      DOUBLE PRECISION TIMUDRIV,TIMUSTEP


* DATA INITIALIZATION

$include ('^/include/ssdata35.dat')
$include ('^/include/ssdata38.dat')
$include ('^/include/ssdata39.dat')
$include ('^/include/ssdata42.dat')
$include ('^/include/ssdata44.dat')
$include ('^/include/ssdata45.dat')
$include ('^/include/ssdata46.dat')
$include ('^/include/ssdata47.dat')
$include ('^/include/ssdata48.dat')
$include ('^/include/ssdata49.dat')
$include ('^/include/ssdata50.dat')
$include ('^/include/ssdata01.dat')
$include ('^/include/ssdata17.dat')
$include ('^/include/ssdata18.dat')
$include ('^/include/ssdata21.dat')
$include ('^/include/ssdata22.dat')
$include ('^/include/ssdata23.dat')
$include ('^/include/ssdata28.dat')
$include ('^/include/ssdata29.dat')
$include ('^/include/ssdata30.dat')
$include ('^/include/ssdata71.dat')
$include ('^/include/sstiming.dat')
```

```
      call cw87

$include ('ssp04.dat')

C-------------------------------------------------------------------------C
C----------------------------- MAIN EXECUTION LOOP -----------------------C
C-------------------------------------------------------------------------C
C                               Execution of all events is performed    C
C                               within this loop                        C
C                                                                       C
C-------------------------------------------------------------------------C


 1000 CONTINUE


C     WRITE(*,*)'--------------BEGINNING OF LOOP-----------------'

C-------------------------------------------------------------------------C
C------------------------ Processor communication ------------------------C
C-------------------------------------------------------------------------C
C--------------------  Communicate with p01 ----------------------------C

      CALL SEND_REAL_32BIT( SNGL(PULSEG(01)) )
      CALL SEND_REAL_32BIT( SNGL(PULSEG(02)) )
      CALL SEND_REAL_32BIT( SNGL(PULSEG(03)) )

      CALL RECEIVE_REAL_32BIT( S_P )
      CALL RECEIVE_REAL_32BIT( S_Q )
      CALL RECEIVE_REAL_32BIT( S_R )
      P = DBLE(S_P)
      Q = DBLE(S_Q)
      R = DBLE(S_R)

      CALL RECEIVE_REAL_32BIT( S_CIM(1) )
      CALL RECEIVE_REAL_32BIT( S_CIM(2) )
      CALL RECEIVE_REAL_32BIT( S_CIM(3) )
      CALL RECEIVE_REAL_32BIT( S_CIM(4) )
      CALL RECEIVE_REAL_32BIT( S_CIM(5) )
      CALL RECEIVE_REAL_32BIT( S_CIM(6) )
      CALL RECEIVE_REAL_32BIT( S_CIM(7) )
      CALL RECEIVE_REAL_32BIT( S_CIM(8) )
      CALL RECEIVE_REAL_32BIT( S_CIM(9) )
      CIM(1) = DBLE(S_CIM(1))
      CIM(2) = DBLE(S_CIM(2))
      CIM(3) = DBLE(S_CIM(3))
      CIM(4) = DBLE(S_CIM(4))
      CIM(5) = DBLE(S_CIM(5))
      CIM(6) = DBLE(S_CIM(6))
      CIM(7) = DBLE(S_CIM(7))
      CIM(8) = DBLE(S_CIM(8))
      CIM(9) = DBLE(S_CIM(9))


C-------------------------------------------------------------------------C
C---------------------------- INERTIAL MEASUREMENT UPDATE ----------------C
C-------------------------------------------------------------------------C
C                               Get inertial measurement data needed    C
C                               for guidance calculations .             C
C                                                                       C
C-------------------------------------------------------------------------C
```

```
      IF ( TSTEP .GE. TIMUDRIV ) THEN

         TIMUDRIV = TIMUDRIV + TIMUSTEP

C-------------------------------------------------------------------------C
C------------------------------ GYRO MODULE ------------------------------C
C-------------------------------------------------------------------------C
C                               Determine sensed body rates .             C
C                                                                         C
C-------------------------------------------------------------------------C


         CALL GYRO(T,P,Q,R,CIM,GYSEED,QFRACG,PULSEG)

      ENDIF

C-------------------------------------------------------------------------C
C---------------------------- TERMINATION LOGIC --------------------------C
C-------------------------------------------------------------------------C
C                               Defines the simulation termination        C
C                               conditions                                C
C                                                                         C
C-------------------------------------------------------------------------C

C     INITIALIZE SIMULATION EXIT FLAG TO ZERO ( PREVENTS EXIT )

      IEXIT  = 0

C     increment time

      TSTEP = TSTEP + 1.0d0
      T = TSTEP * DELT

C     CONTINUE LOOPING UNTIL ONE OR MORE EXIT CONDITIONS HAVE BEEN MET

      IF ( IEXIT.EQ.0 ) GO TO 1000

      END
```

## B.1.6 Uup05.for

```
c      PROGRAM EXOSIM
C-------------------------------------------------------------------------C
C--------------- Declare and initialize variables  ---------------------C
C-------------------------------------------------------------------------C

      IMPLICIT REAL          (A-H)
      IMPLICIT REAL          (O-Z)

      CHARACTER*128 MESSAGE

C     THE FOLLOWING COMMON BLOCK USED FOR MIDFLIGHT CAPABILITIES ONLY

      COMMON / NORCOM / GSET    , ISET
      COMMON / RANCOM / RANSEQ , RANLST
      COMMON / RACSTR / TREFLA , TLSTC  , ACSF    , AOFF1  , AOFF2  ,
     .                  TMACSA , THACSA , LENA    , TMACSB , THACSB ,
     .                  LENB

      REAL  CG(3)
      REAL  MXACS         ,  MYACS         ,  MZACS    ,  MDOTA
      REAL  RANSEQ(97)    ,  RANLST,AOFF2(4),  AOFF1(4)
      REAL  TMACSA(8,4)   ,  THACSA(8,4)   ,  DTACSA(4)
      REAL  TMACSB(8,4)   ,  THACSB(8,4)   ,  DTACSB(4)

      double precision d_cg(3)
      double precision d_MXACS,  d_MYACS,  d_MZACS, d_MDOTA
      double precision d_fxacs,d_fyacs,d_fzacs
      double precision d_acslev,d_dtacsa(4),d_dtacsb(4)
      double precision d_tatab

      INTEGER           LENA(4)       ,  LENB(4)
      INTEGER           SEKTYP
      INTEGER*4           TOSEED

       REAL TSTEP,DELT,latlp,longlp
       REAL TMSUDRIV, TMSUSTEP

* DATA INITIALIZATION
$INCLUDE('^/INCLUDE/SSDATA35.DAT')
$INCLUDE('^/INCLUDE/SSDATA38.DAT')
$INCLUDE('^/INCLUDE/SSDATA39.DAT')
$INCLUDE('^/INCLUDE/SSDATA42.DAT')
$INCLUDE('^/INCLUDE/SSDATA44.DAT')
$INCLUDE('^/INCLUDE/SSDATA45.DAT')
$INCLUDE('^/INCLUDE/SSDATA46.DAT')
$INCLUDE('^/INCLUDE/SSDATA47.DAT')
$INCLUDE('^/INCLUDE/SSDATA48.DAT')
$INCLUDE('^/INCLUDE/SSDATA49.DAT')
$INCLUDE('^/INCLUDE/SSDATA50.DAT')
$INCLUDE('^/INCLUDE/SSDATA01.DAT')
$INCLUDE('^/INCLUDE/SSDATA17.DAT')
$INCLUDE('^/INCLUDE/SSDATA18.DAT')
$INCLUDE('^/INCLUDE/SSDATA21.DAT')
$INCLUDE('^/INCLUDE/SSDATA22.DAT')
$INCLUDE('^/INCLUDE/SSDATA23.DAT')
$INCLUDE('^/INCLUDE/SSDATA28.DAT')
$INCLUDE('^/INCLUDE/SSDATA29.DAT')
$INCLUDE('^/INCLUDE/SSDATA30.DAT')
$INCLUDE('^/INCLUDE/SSDATA71.DAT')
$INCLUDE('^/INCLUDE/SSTIMING.DAT')
```

```
* INITIALIZE 80x87
      CALL CW87

C     DETERMINE IF MIDFLIGHT RESTART
$INCLUDE('SSp05.DAT')


C-------------------------------------------------------------------------C
C----------------------------- MAIN EXECUTION LOOP -----------------------C
C-------------------------------------------------------------------------C
C                               Execution of all events is performed      C
C                               within this loop                          C
C                                                                         C
C-------------------------------------------------------------------------C


 100 CONTINUE


C     WRITE(*,*)'--------------BEGINNING OF LOOP-----------------'

C-------------------------------------------------------------------------C
C--------------------------- MISSILE STATE UPDATE MODULE -----------------C
C-------------------------------------------------------------------------C
C                             Integrate missile states to current time    C
C                                                                         C
C-------------------------------------------------------------------------C

C--------- recieve from masspr (P00) ----------C

      CALL RECEIVE_REAL_32BIT( cg(01) )
      CALL RECEIVE_REAL_32BIT( cg(02) )
      CALL RECEIVE_REAL_32BIT( cg(03) )

C--------- Send variables to masspr and missil (p00) ------------------C

      CALL send_REAL_32BIT( mdota )

      CALL send_REAL_32BIT( fxacs )
      CALL send_REAL_32BIT( fyacs )
      CALL send_REAL_32BIT( fzacs )

      CALL send_REAL_32BIT( mxacs )
      CALL send_REAL_32BIT( myacs )
      CALL send_REAL_32BIT( mzacs )


C---------- Communication with p01 -----------------C
      CALL RECEIVE_REAL_32BIT( ACSLEV )
      CALL RECEIVE_REAL_32BIT( DTACSA(01) )
      CALL RECEIVE_REAL_32BIT( DTACSA(02) )
      CALL RECEIVE_REAL_32BIT( DTACSA(03) )
      CALL RECEIVE_REAL_32BIT( DTACSA(04) )
      CALL RECEIVE_REAL_32BIT( DTACSB(01) )
      CALL RECEIVE_REAL_32BIT( DTACSB(02) )
      CALL RECEIVE_REAL_32BIT( DTACSB(03) )
      CALL RECEIVE_REAL_32BIT( DTACSB(04) )
      CALL RECEIVE_SIGNED_16BIT( ITHRES )
      CALL RECEIVE_REAL_32BIT( TATAB )

      CALL SEND_SIGNED_16BIT( IACSON )

C-------------------------------------------------------------------------
```

```
      IF ( tstep .gE. tmsudriv ) THEN

         tmsudriv = tmsudriv + tmsustep


         IF ( T.GE.TKVON ) THEN

C-------------------------------------------------------------------------C
C----------------------------- ACS THRUSTER RESPONSE MODULE ----------C
C-------------------------------------------------------------------------C
C                               Determines the forces and moments       C
C                               imparted by the ACS thrusters           C
C                                                                       C
C-------------------------------------------------------------------------C

            CALL ACSTHR(T,CG,ACSLEV,DTACSA,DTACSB,TATAB,TOSEED,
     .                  tbrk,ITHRES,FXACS,FYACS,FZACS,MXACS,MYACS,MZACS,
     .                      MDOTA,IACSON,TIMONA)

         ENDIF

      ENDIF


C-------------------------------------------------------------------------C
C----------------------------- TERMINATION LOGIC ---------------------C
C-------------------------------------------------------------------------C
C                               Defines the simulation termination      C
C                               conditions                              C
C                                                                       C
C-------------------------------------------------------------------------C

C     INITIALIZE SIMULATION EXIT FLAG TO ZERO ( PREVENTS EXIT )

      IEXIT  = 0

C     increment time

      TSTEP = TSTEP + 1.0e0
      T = TSTEP * DELT

C     CONTINUE LOOPING UNTIL ONE OR MORE EXIT CONDITIONS HAVE BEEN MET

      IF ( IEXIT.EQ.0 ) GO TO 1000

      END
```

## B.1.7 Uup06.for

```
c      PROGRAM EXOSIM
C-------------------------------------------------------------------------C
C--------------- Declare and initialize variables  ---------------------C
C-------------------------------------------------------------------------C

      IMPLICIT REAL         (A-H)
      IMPLICIT REAL         (O-Z)

      CHARACTER*128 MESSAGE

      real  CGX(20)       , CGY(20)       ,  CGZ(20)
      real  MASST1(20)

      real  CG(3)         ,  MASS
      INTEGER           iexit        ,  icg

      real TSTEP,DELT
      real TMSUDRIV,TMSUSTEP

* DATA INITIALIZATION
$INCLUDE('^/INCLUDE/SSMAS_cg.DAT')

* INITIALIZE 80x87
      CALL CW87

C        RESTARTING FROM MIDFLIGHT DATA FILE
$INCLUDE('SSp06.DAT')


C------ -------------------------------------------------------------------C
C----------------------------- MAIN EXECUTION LOOP ---------------------C
C-------------------------------------------------------------------------C
C                              Execution of all events is performed     C
C                              within this loop                         C
C                                                                       C
C-------------------------------------------------------------------------C

 1000 CONTINUE

C     WRITE(*,*)'--------------BEGINNING OF LOOP-----------------'

C-------------------------------------------------------------------------C
C--------------------------- MISSILE STATE UPDATE MODULE --------------C
C-------------------------------------------------------------------------C
C                             Integrate missile states to current time  C
C                                                                       C
C-------------------------------------------------------------------------C


      IF ( tstep .gE. tmsudriv ) THEN

         tmsudriv = tmsudriv + tmsustep

         dt     = tmsustep * delt

C-------------------------------------------------------------------------C
C---------------------------- MASS PROPERTIES MODULE -------------------C
C-------------------------------------------------------------------------C
C                               Update cg                               C
C                                                                       C
C-------------------------------------------------------------------------C
```

```
C     CALCULATE MISSILE CENTER OF GRAVITY COMPONENTS

         CALL spTABLE(MASST1,CGX,MASS,CG(1),20,ICG)
         CALL spTABLE(MASST1,CGY,MASS,CG(2),20,ICG)
         CALL spTABLE(MASST1,CGZ,MASS,CG(3),20,ICG)

      ENDIF

C-------------------------------------------------------------------------C
C---------------------- Processor communication --------------------------C
C-------------------------------------------------------------------------C

c------ communication with missil model

      call receive_real_32bit( mass )

C------ send to ACSTHR and VCSTHR and ACCEL

      CALL send_REAL_32BIT( cg(01) )
      CALL send_REAL_32BIT( cg(02) )
      CALL send_REAL_32BIT( cg(03) )

C-------------------------------------------------------------------------C
C----------------------------- OUTPUT MODULE -----------------------------C
C-------------------------------------------------------------------------C
C                              Creates print and plot output data       C
C                              files                                    C
C                                                                       C
C-------------------------------------------------------------------------C

C      if (  mod(idnint(tstep),idnint(dtprt)).eq.0 ) then

C      ENDIF

C-------------------------------------------------------------------------C
C---------------------------- TERMINATION LOGIC --------------------------C
C-------------------------------------------------------------------------C
C                              Defines the simulation termination       C
C                              conditions                               C
C                                                                       C
C-------------------------------------------------------------------------C

C     INITIALIZE SIMULATION EXIT FLAG TO ZERO ( PREVENTS EXIT )

      IEXIT  = 0

C     increment time

      TSTEP = TSTEP + 1.0
      T = TSTEP * DELT

C     CONTINUE LOOPING UNTIL ONE OR MORE EXIT CONDITIONS HAVE BEEN MET

      IF ( IEXIT.EQ.0 ) GO TO 1000

      END
```

## B.1.8 Uup07.for

```
c      PROGRAM EXOSIM
C-------------------------------------------------------------------C
C--------------- Declare and initialize variables  -----------------C
C-------------------------------------------------------------------C

C-------------------------------------------------------------------C

      IMPLICIT REAL          (A-H)
      IMPLICIT REAL          (O-Z)

      CHARACTER*128 MESSAGE

      REAL TSTEP,DELT
      REAL TIMUDRIV,TIMUSTEP,TGPUDRIV,TGPUSTEP

      REAL  MVR           ,  MVS           ,  VTTP(3),     AT(3)
      REAL  VS(3)         ,  VTT(3)        ,  VG(3)  ,     US(3)
      real  vc(3)         ,  uvs(3)        ,  dlv(3)
      REAL X,Y,Z,XD,YD,ZD
      REAL RMIR(3),VMIR(3)

      REAL LONGLP, LATLP
      INTEGER SEKTYP

* DATA INITIALIZATION
$INCLUDE('^/INCLUDE/SSDATA35.DAT')
$INCLUDE('^/INCLUDE/SSDATA38.DAT')
$INCLUDE('^/INCLUDE/SSDATA39.DAT')
$INCLUDE('^/INCLUDE/SSDATA42.DAT')
$INCLUDE('^/INCLUDE/SSDATA44.DAT')
$INCLUDE('^/INCLUDE/SSDATA45.DAT')
$INCLUDE('^/INCLUDE/SSDATA46.DAT')
$INCLUDE('^/INCLUDE/SSDATA47.DAT')
$INCLUDE('^/INCLUDE/SSDATA48.DAT')
$INCLUDE('^/INCLUDE/SSDATA49.DAT')
$INCLUDE('^/INCLUDE/SSDATA50.DAT')
$INCLUDE('^/INCLUDE/SSDATA01.DAT')
$INCLUDE('^/INCLUDE/SSDATA17.DAT')
$INCLUDE('^/INCLUDE/SSDATA18.DAT')
$INCLUDE('^/INCLUDE/SSDATA21.DAT')
$INCLUDE('^/INCLUDE/SSDATA22.DAT')
$INCLUDE('^/INCLUDE/SSDATA23.DAT')
$INCLUDE('^/INCLUDE/SSDATA28.DAT')
$INCLUDE('^/INCLUDE/SSDATA29.DAT')
$INCLUDE('^/INCLUDE/SSDATA30.DAT')
$INCLUDE('^/INCLUDE/SSDATA71.DAT')
$INCLUDE('^/INCLUDE/SSTIMING.DAT')

* INITIALIZE 80x87
      CALL CW87

$INCLUDE('SSp07.DAT')

C-------------------------------------------------------------------C
C----------------------------- MAIN EXECUTION LOOP -----------------C
C-------------------------------------------------------------------C
C                              Execution of all events is performed  C
C                              within this loop                      C
C                                                                    C
C-------------------------------------------------------------------C
```

```
c      CALL INITIALIZE_TIMING()

 1000 CONTINUE

c      CALL START_TIMING(0)

C     WRITE(*,*)'--------------BEGINNING OF LOOP-----------------'

C-------------------------------------------------------------------------C
C---------------------- Processor communication ----------------------C
C-------------------------------------------------------------------------C


c      CALL SWITCH_TIMING()

C----------------------- COMMUNICATION WITH P00 -----------------------C

      CALL RECEIVE_REAL_32BIT( X )
      CALL RECEIVE_REAL_32BIT( Y )
      CALL RECEIVE_REAL_32BIT( Z )
      CALL RECEIVE_REAL_32BIT( XD )
      CALL RECEIVE_REAL_32BIT( YD )
      CALL RECEIVE_REAL_32BIT( ZD )

      CALL RECEIVE_REAL_32BIT( RMIR(1) )
      CALL RECEIVE_REAL_32BIT( RMIR(2) )
      CALL RECEIVE_REAL_32BIT( RMIR(3) )
      CALL RECEIVE_REAL_32BIT( VMIR(1) )
      CALL RECEIVE_REAL_32BIT( VMIR(2) )
      CALL RECEIVE_REAL_32BIT( VMIR(3) )

C----------------------- COMMUNICATION WITH P01 -----------------------C

      CALL RECEIVE_REAL_32BIT( at(1) )
      CALL RECEIVE_REAL_32BIT( at(2) )
      CALL RECEIVE_REAL_32BIT( at(3) )
      CALL SEND_REAL_32BIT( VG(1) )
      CALL SEND_REAL_32BIT( VG(2) )
      CALL SEND_REAL_32BIT( VG(3) )

c      CALL SWITCH_TIMING()

C-------------------------------------------------------------------------C
C----------------------------- INERTIAL MEASUREMENT UPDATE ------------C
C-------------------------------------------------------------------------C
C                              Get inertial measurement data needed    C
C                              for guidance calculations .             C
C                                                                      C
C-------------------------------------------------------------------------C


      IF ( TSTEP .GE. TIMUDRIV ) THEN

         TIMUDRIV = TIMUDRIV + TIMUSTEP

C        TIME SINCE LAST INERTIAL MEASUREMENT UPDATE

         DT     = TIMUSTEP * DELT

C        INTEGRATE GRAVITY COMPENSATED ACCELERATION

         VTT(1) = VTT(1) + DT*AT(1)
         VTT(2) = VTT(2) + DT*AT(2)
         VTT(3) = VTT(3) + DT*AT(3)
```

```
      ENDIF

C-------------------------------------------------------------------------C
C----------------------------- MIDCOURSE CORRECTION ----------------------C
C-------------------------------------------------------------------------C
C                               Models uplink of interceptor,             C
C                               target, and intercept conditions          C
C                                                                         C
C-------------------------------------------------------------------------C

      IF ( ( ABS(T-TUPLK1).LE.DTEPS ) .OR.
     *     ( ABS(T-TUPLK2).LE.DTEPS ) ) THEN

C        REVISE ESTIMATED MISSILE STATES

         VMIR(1)    = XD
         VMIR(2)    = YD
         VMIR(3)    = ZD

         RMIR(1)    = X
         RMIR(2)    = Y
         RMIR(3)    = Z

      ENDIF

C-------------------------------------------------------------------------C
C                              ON BOARD GUIDANCE PROCESSING               C
C-------------------------------------------------------------------------C
C                              Determine guidance commands                C
C                                                                         C
C-------------------------------------------------------------------------C

      IF ( TSTEP .GE. TGPUDRIV ) THEN

         TGPUDRIV = TGPUDRIV + TGPUSTEP

C-------------------------------------------------------------------------C
C----------------------------- CORRELATED VELOCITY MODULE ----------------C
C-------------------------------------------------------------------------C
C                               This section calculates the correlated    C
C                               velocity vector (VC) through an iter-     C
C                               ative process.  From VC, the steering     C
C                               velocity vector is produced by sub-       C
C                               tracting a bias velocity (VD0) from the   C
C                               velocity to be gained (VG).               C
C                                                                         C
C-------------------------------------------------------------------------C


         IF ( T.GE.TCORV .AND. T.LE.(TTF-DTSPVC) ) THEN

            CALL CORVEL(T,MVR,VTT,RMIR,VMIR,VTTP,VG,VS,MVS,UVS,VC,
     .                  DLV,TFFE,TTFE)

            DTMP1   = DTCVU * ANINT ( (T+DTCVU) / DTCVU )
            TCORV   = DTMP1
         ENDIF
```

```
      ENDIF

C-------------------------------------------------------------------------C
C------------------------------ OUTPUT MODULE ----------------------------C
C-------------------------------------------------------------------------C

c         call stop_timing()

c      if (  mod(int(tstep),int(dtprt)).eq.0 ) then
c         call output_timing()
c         call INITIALIZE_TIMING()
c      ENDIF

C-------------------------------------------------------------------------C
C---------------------------- TERMINATION LOGIC --------------------------C
C-------------------------------------------------------------------------C
C                              Defines the simulation termination       C
C                              conditions                               C
C                                                                       C
C-------------------------------------------------------------------------C

C     INITIALIZE SIMULATION EXIT FLAG TO ZERO ( PREVENTS EXIT )

      IEXIT  = 0

C     ENABLE EXIT IF MAXIMUM SIMULATION TIME HAS BEEN EXECUTED AND ALL
C     EVENTS SCHEDULED FOR THIS TIME HAVE BEEN EXECUTED

      IF ( T.GE.TFINAL ) THEN
         IEXIT  = 1
      ENDIF

C     increment time

      TSTEP = TSTEP + 1.0D0
      T = TSTEP * DELT

C     CONTINUE LOOPING UNTIL ONE OR MORE EXIT CONDITIONS HAVE BEEN MET

      IF ( IEXIT.EQ.0 ) GO TO 1000

      END
```

## B.1.9 Uup08.for

```
c      PROGRAM EXOSIM
C-------------------------------------------------------------------------C
C--------------- Declare and initialize variables  ---------------------C
C-------------------------------------------------------------------------C
C-------------------------------------------------------------------------C

      IMPLICIT DOUBLE PRECISION         (A-H)
      IMPLICIT DOUBLE PRECISION         (O-Z)

      CHARACTER*128 MESSAGE
C     THE FOLLOWING COMMON BLOCKS USED FOR MIDFLIGHT CAPABILITIES ONLY

      COMMON / STORAG / XINT   , TINT   , XDOTL
      COMMON / RMISSL / XYZLCH

      REAL S_MASS,S_CIM(9),S_FXACS,S_FYACS,S_FZACS
      REAL S_FXVCS,S_FYVCS,S_FZVCS

      DOUBLE PRECISION  XINT(50)      ,  TINT(50)      ,  XDOTL(50)
      DOUBLE PRECISION  SF1G(3)       ,  SF2G(3)       ,  DCG(3)
      DOUBLE PRECISION  SF1A(3)       ,  SF2A(3)       ,  DCA(3)
      DOUBLE PRECISION  OMEGA0(3)     ,  XYZLCH(3)     ,  EVTIME(20)
      DOUBLE PRECISION  MASSL         ,  MACHL         ,  ANGACL(3,4,10)
      DOUBLE PRECISION  OMEGAI(3)     ,  GRTLST(5,3)   ,  CIMO(9)
      DOUBLE PRECISION  WBI2(3)       ,  WBI1(3)       ,  WBO2(3)
      DOUBLE PRECISION  WBO1(3)       ,  GRLST(3)      ,  XYZDP(3)
      DOUBLE PRECISION  ABI2(3)       ,  ABI1(3)       ,  ABO2(3)
      DOUBLE PRECISION  ABO1(3)       ,  GRLAST(3)     ,  GRTPST(3)
      DOUBLE PRECISION  TLATCH(10)    ,  LAMMSV(2,10)  ,  RRELSV(3,10)
      DOUBLE PRECISION  VRELSV(3,10)  ,  TI2MSV(9,10)  ,  SNRSV(10)
      DOUBLE PRECISION  AACCEL(3,4)

      DOUBLE PRECISION  CGX(20)       ,  CGY(20)       ,  CGZ(20)
      DOUBLE PRECISION  MASST1(20)    ,  MASST2(20)

      REAL              RANSEQ(97)    ,  RANLST        ,  RAND1(98)

      INTEGER           IEVFLG(20)    ,  FIRST1        ,  FIRST2
      INTEGER           ISEQ(4)       ,  IMCPAS(3,4)   ,  FLIP
      INTEGER           VCOD(4)       ,  GATE

C     OUTPUTS

      DOUBLE PRECISION  MXA           ,  MYA           ,  MZA
      DOUBLE PRECISION  MXT           ,  MYT           ,  MZT
      DOUBLE PRECISION  MRCX          ,  MRCY          ,  MRCZ
      DOUBLE PRECISION  MXVCS         ,  MYVCS         ,  MZVCS
      DOUBLE PRECISION  MXACS         ,  MYACS         ,  MZACS
      DOUBLE PRECISION  MX            ,  MY            ,  MZ
      DOUBLE PRECISION  MACH          ,  MDOTT         ,  MDOTF
      DOUBLE PRECISION  MDOTV         ,  MDOTA         ,  LFRACS
      DOUBLE PRECISION  KN            ,  KM            ,  MDLTFR
      DOUBLE PRECISION  KTHT          ,  KTHTD         ,  MDELTA
      DOUBLE PRECISION  KNE           ,  KME           ,  MALPHA
      DOUBLE PRECISION  LATT          ,  LONGT         ,  MVS
      DOUBLE PRECISION  KA            ,  KV            ,  MAGRTR
      DOUBLE PRECISION  MAGLOS        ,  MGRDTR        ,  MAGR
      DOUBLE PRECISION  MAGV          ,  MGRDOT        ,  MXYZDD
      DOUBLE PRECISION  MGR           ,  LAT           ,  LONG
      DOUBLE PRECISION  MISS          ,  MVR           ,  MVRWM
      DOUBLE PRECISION  ATHRF(4)      ,  CMMD(2)       ,  VCMDL(4)
```

```
      DOUBLE PRECISION  RTER(3)       ,  CTI(9)        ,  CMS(9)
      DOUBLE PRECISION  CIT(9)        ,  GRT(5,3)      ,  ADISTT(4,3)
      DOUBLE PRECISION  RTAR(3)       ,  VTAR(3)       ,  UVS(3)
      DOUBLE PRECISION  VC(3)         ,  DLV(3)        ,  VTTP(3)
      DOUBLE PRECISION  VS(3)         ,  US(3)         ,  AC(3)
      DOUBLE PRECISION  CIR(9)        ,  CIM(9)        ,  CMI(9)
      DOUBLE PRECISION  VW(3)         ,  WC(3)         ,  PM(3)
      DOUBLE PRECISION  CGEST(3)      ,  RRELTR(3)     ,  VRELTR(3)
      DOUBLE PRECISION  LAMTRU(2)     ,  LAMDXX(2)     ,  LAMDTR(2)
      DOUBLE PRECISION  LAMSEK(2)     ,  LAMDSK(2)     ,  LAMM(2)
      DOUBLE PRECISION  RTEST(3)      ,  RREL(3)       ,  URREL(3)
      DOUBLE PRECISION  VREL(3)       ,  TI2M(9)       ,  USI(3)
      DOUBLE PRECISION  QS1(4)        ,  VMI(3)        ,  RMI(3)
      DOUBLE PRECISION  VMIR(3)       ,  RMIR(3)       ,  VTEST(3)
      DOUBLE PRECISION  AT(3)         ,  XYZR(3)       ,  GB(3)
      DOUBLE PRECISION  GR(3)         ,  CER(9)        ,  CRI(9)
      DOUBLE PRECISION  VRWM(3)       ,  CEI(9)        ,  CIE(9)
      DOUBLE PRECISION  PG(3)         ,  VTT(3)        ,  US0(3)
      DOUBLE PRECISION  PG0(3)        ,  USF(3)        ,  QUATIC(4)
      DOUBLE PRECISION  TI2MO(9)      ,  GREST(3)
      DOUBLE PRECISION  LAMMO(2)      ,  RRELO(3)      ,  VRELO(3)
      DOUBLE PRECISION  RRELM(3)      ,  VRELM(3)      ,  GRTEST(3)
      DOUBLE PRECISION  FOFF1(4)      ,  FOFF2(4)

C     NAMELIST INPUTS

      DOUBLE PRECISION  IXX           ,  IYY           ,  IZZ
      DOUBLE PRECISION  CG(3)         ,  MASS          ,  PQR(3)
      DOUBLE PRECISION  IMPULS        ,  QUAT(4)       ,  MDOT
      DOUBLE PRECISION  QUATD(4)         BOFF2(2)      ,  TMVCS(6,4)
      DOUBLE PRECISION  THVCS(6,4)    ,  DTOFFV(4)     ,  VG(3)
      DOUBLE PRECISION  TMACSA(8,4)   ,  THACSA(8,4)   ,  DTACSA(4)
      DOUBLE PRECISION  TMACSB(8,4)   ,  THACSB(8,4)   ,  DTACSB(4)
      DOUBLE PRECISION  XYZE(3)       ,  XYZED(3)      ,  RTIC(5,3)
      DOUBLE PRECISION  VTIC(5,3)     ,  PULSEG(3)     ,  QFRACG(3)
      DOUBLE PRECISION  PULSEA(3)     ,  QFRACA(3)     ,  XYZEDD(3)
      DOUBLE PRECISION  LAM(2)        ,  LAMD(2)       ,  VGM(3)
      DOUBLE PRECISION  DTVCSP(3)     ,  DTVCSY(3)     ,  FLTC(4)
      DOUBLE PRECISION  TOFFLT(4)     ,  TMF(8,4)      ,  THF(8,4)
      DOUBLE PRECISION  DTOFF(4)      ,  VWIC(3)       ,  AOFF1(4)
      DOUBLE PRECISION  VTTIC(3)      ,  USD(3)        ,  VCMD(4)
      DOUBLE PRECISION  PGD(3)        ,  VWD(3)        ,  MASS0
      DOUBLE PRECISION  MSSTG2        ,  LATLP         ,  LONGLP
      DOUBLE PRECISION  IMPLS0        ,  MVRDOT        ,  CAZ(100)
      DOUBLE PRECISION  CEL(100)      ,  RJ(5)
      DOUBLE PRECISION  AZSUB(100)    ,  ELSUB(100)    ,  RJSUB(100)
      DOUBLE PRECISION  AOFF2(4)

      INTEGER           LENVCS(4)     ,  LENA(4)       ,  LENB(4)
      INTEGER           LENF(4)       ,  GYSEED        ,  FRMCNT
      INTEGER           SKSEED        ,  SEKTYP        ,  ACQD
      INTEGER           TERM          ,  TOSEED        ,  VLVCM5
      INTEGER           ESTATE
      INTEGER           TRACK
      INTEGER           ROWBEG        ,  COLBEG        ,  PLOTNO

       DOUBLE PRECISION TSTEP,DELT
       DOUBLE PRECISION TMSUDRIV,TTSUDRIV,TRSUDRIV,TIMUDRIV,
     *                  TGPUDRIV,TAPUDRIV,TSPUDRIV,TKFUDRIV
       DOUBLE PRECISION TMSUSTEP,TTSUSTEP,TRSUSTEP,TIMUSTEP,
     *                  TGPUSTEP,TAPUSTEP,TSPUSTEP,TKFUSTEP
       Integer irst,jrst,krst

* DATA INITIALIZATION
```

```
$INCLUDE('^/INCLUDE/SSDATA35.DAT')
$INCLUDE('^/INCLUDE/SSDATA38.DAT')
$INCLUDE('^/INCLUDE/SSDATA39.DAT')
$INCLUDE('^/INCLUDE/SSDATA42.DAT')
$INCLUDE('^/INCLUDE/SSDATA44.DAT')
$INCLUDE('^/INCLUDE/SSDATA45.DAT')
$INCLUDE('^/INCLUDE/SSDATA46.DAT')
$INCLUDE('^/INCLUDE/SSDATA47.DAT')
$INCLUDE('^/INCLUDE/SSDATA48.DAT')
$INCLUDE('^/INCLUDE/SSDATA49.DAT')
$INCLUDE('^/INCLUDE/SSDATA50.DAT')
$INCLUDE('^/INCLUDE/SSDATA01.DAT')
$INCLUDE('^/INCLUDE/SSDATA17.DAT')
$INCLUDE('^/INCLUDE/SSDATA18.DAT')
$INCLUDE('^/INCLUDE/SSDATA21.DAT')
$INCLUDE('^/INCLUDE/SSDATA22.DAT')
$INCLUDE('^/INCLUDE/SSDATA23.DAT')
$INCLUDE('^/INCLUDE/SSDATA28.DAT')
$INCLUDE('^/INCLUDE/SSDATA29.DAT')
$INCLUDE('^/INCLUDE/SSDATA30.DAT')
$INCLUDE('^/INCLUDE/SSDATA71.DAT')
$INCLUDE('^/INCLUD./SSTIMING.DAT')

$INCLUDE('^/INCLUDE/SSMAS_cg.DAT')

      DATA IMASS  , IAERO  ,  IBTHR  ,  IBAUTO  /  1 , 1 , 1 , 1 /

* INITIALIZE 80x87
      CALL CW87
$INCLUDE('SSp08.DAT')


C-------------------------------------------------------------- ---------C
C------------------------------ MAIN EXECUTION LOOP ------------------C
C-------------------------------------------------------------------------C
C                               Execution of all events is performed    C
C                               within this loop                        C
C                                                                       C
C-----------------------------------------------------------------------C

 1000 CONTINUE

C     WRITE(*,*)'--------------BEGINNING OF LOOP-----------------'

C-------------------------------------------------------------------------C
C--------------------------- MISSILE STATE UPDATE MODULE -----------------C
C-------------------------------------------------------------------------C
C                             Integrate missile states to current time  C
C                                                                       C
C-----------------------------------------------------------------------C


      IF ( tstep .gE. tmsudriv ) THEN

         tmsudriv = tmsudriv + tmsustep

C-------------------------------------------------------------------------C
C------------------------------ VEHICLE STATES MODULE --------------------C
C-------------------------------------------------------------------------C
C                               Compute missile state derivatives       C
C                                                                       C
C-------------------------------------------------------------- ---------C
```

```
      CALL MISSIL(T,CIM,MASS,
     .            FXACS,FXVCS,FYACS,FYVCS,
     .            FZACS,FZVCS,
     .            X,Y,Z,NCLEAR,UD,VD,WD,
     .            GB,GR,MGR,FX,FY,FZ,XDD,YDD,ZDD,MXYZDD)

C-----------------------------------------------------------------------C
C                            MISSILE STATE INTEGRATION MODULE           C
C-----------------------------------------------------------------------C
C                            Revise missile states using derivatives    C
C                            just computed . Missile states must not    C
C                            be integrated if a table lookup index      C
C                            transition has occurred since the last     C
C                            integration step . The next integration    C
C                            step should be rescheduled to coincide     C
C                            with the earliest detected table lookup    C
C                            index transition instead . Otherwise       C
C                            schedule the next integration step to      C
C                            occur at the default step size .           C
C                                                                       C
C-----------------------------------------------------------------------C

C       TRAPEZOIDAL INTEGRATION FOR SIMPLICITY

        CALL INTEG ( XD      , XDD      , T ,  6 )
        CALL INTEG ( YD      , YDD      , T ,  7 )
        CALL INTEG ( ZD      , ZDD      , T ,  8 )
        CALL INTEG ( X       , XD       , T ,  9 )
        CALL INTEG ( Y       , YD       , T , 10 )
        CALL INTEG ( Z       , ZD       , T , 11 )

C       TRANSFORM INERTIAL POSITION AND VELOCITY TO EARTH FRAME

        XYZE(1)   = CIE(1)*X   + CIE(4)*Y   + CIE(7)*Z
        XYZE(2)   = CIE(2)*X   + CIE(5)*Y   + CIE(8)*Z
        XYZE(3)   = CIE(3)*X   + CIE(6)*Y   + CIE(9)*Z

        XYZED(1)  = CIE(1)*XD  + CIE(4)*YD  + CIE(7)*ZD
        XYZED(2)  = CIE(2)*XD  + CIE(5)*YD  + CIE(8)*ZD
        XYZED(3)  = CIE(3)*XD  + CIE(6)*YD  + CIE(9)*ZD

        XYZEDD(1) = CIE(1)*XDD + CIE(4)*YDD + CIE(7)*ZDD
        XYZEDD(2) = CIE(2)*XDD + CIE(5)*YDD + CIE(8)*ZDD
        XYZEDD(3) = CIE(3)*XDD + CIE(6)*YDD + CIE(9)*ZDD

C       ROTATING EARTH MODEL

        CALL MMK(0.0D0,1,0.0D0,2,OMEGAE*T,3,CER)

        XYZR(1) = CER(1)*XYZE(1) + CER(4)*XYZE(2) + CER(7)*XYZE(3)
        XYZR(2) = CER(2)*XYZE(1) + CER(5)*XYZE(2) + CER(8)*XYZE(3)
        XYZR(3) = CER(3)*XYZE(1) + CER(6)*XYZE(2) + CER(9)*XYZE(3)

        CIR(1)  = CER(1)*CIE(1) + CER(4)*CIE(2) + CER(7)*CIE(3)
        CIR(2)  = CER(2)*CIE(1) + CER(5)*CIE(2) + CER(8)*CIE(3)
        CIR(3)  = CER(3)*CIE(1) + CER(6)*CIE(2) + CER(9)*CIE(3)
        CIR(4)  = CER(1)*CIE(4) + CER(4)*CIE(5) + CER(7)*CIE(6)
        CIR(5)  = CER(2)*CIE(4) + CER(5)*CIE(5) + CER(8)*CIE(6)
        CIR(6)  = CER(3)*CIE(4) + CER(6)*CIE(5) + CER(9)*CIE(6)
        CIR(7)  = CER(1)*CIE(7) + CER(4)*CIE(8) + CER(7)*CIE(9)
        CIR(8)  = CER(2)*CIE(7) + CER(5)*CIE(8) + CER(8)*CIE(°)
        CIR(9)  = CER(3)*CIE(7) + CER(6)*CIE(8) + CER(9)*CIE(9)
```

```
          CRI(1)  = CIR(1)
          CRI(2)  = CIR(4)
          CRI(3)  = CIR(7)
          CRI(4)  = CIR(2)
          CRI(5)  = CIR(5)
          CRI(6)  = CIR(8)
          CRI(7)  = CIR(3)
          CRI(8)  = CIR(6)
          CRI(9)  = CIR(9)

C         CALCULATE CURRENT LATITUDE AND LONGITUDE

          LAT     = DATAN2(XYZR(3),DSQRT(XYZR(1)**2+XYZR(2)**2))/DTR
          LONG    = DATAN2(XYZR(2),XYZR(1))/DTR

C         CALCULATE CURRENT MISSILE ALTITUDE

          ALT     = DSQRT ( X**2 + Y**2 + Z**2 ) - RADE

C         SAVE TIME OF LAST MISSILE STATE UPDATE

          TLMSU   = T

        ENDIF


C-------------------------------------------------------------------C
C---------------------- Processor communication ---------------------C
C-------------------------------------------------------------------C

C---------  Communicate with p01  -----------C

        CALL SEND_REAL_32BIT( SNGL(GR(01)) )
        CALL SEND_REAL_32BIT( SNGL(GR(02)) )
        CALL SEND_REAL_32BIT( SNGL(GR(03)) )
        CALL RECEIVE_REAL_32BIT( S_MASS )
        MASS = S_MASS
        CALL SEND_REAL_64BIT( XYZE(01) )
        CALL SEND_REAL_64BIT( XYZE(02) )
        CALL SEND_REAL_64BIT( XYZE(03) )
        CALL SEND_REAL_64BIT( XYZED(01) )
        CALL SEND_REAL_64BIT( XYZED(02) )
        CALL SEND_REAL_64BIT( XYZED(03) )

C-------------  Communicate with p03 -------------------------------C

        CALL SEND_REAL_64BIT( X )
        CALL SEND_REAL_64BIT( Y )
        CALL SEND_REAL_64BIT( Z )
        CALL SEND_REAL_32BIT( SNGL(X) )
        CALL SEND_REAL_32BIT( SNGL(Y) )
        CALL SEND_REAL_32BIT( SNGL(Z) )
        CALL SEND_REAL_32BIT( SNGL(XD) )
        CALL SEND_REAL_32BIT( SNGL(YD) )
        CALL SEND_REAL_32BIT( SNGL(ZD) )
        CALL RECEIVE_REAL_32BIT( S_CIM(1) )
        CALL RECEIVE_REAL_32BIT( S_CIM(2) )
        CALL RECEIVE_REAL_32BIT( S_CIM(3) )
        CALL RECEIVE_REAL_32BIT( S_CIM(4) )
        CALL RECEIVE_REAL_32BIT( S_CIM(5) )
        CALL RECEIVE_REAL_32BIT( S_CIM(6) )
        CALL RECEIVE_REAL_32BIT( S_CIM(7) )
        CALL RECEIVE_REAL_32BIT( S_CIM(8) )
```

```
      CALL RECEIVE_REAL_32BIT( S_CIM(9) )
      CIM(1) = S_CIM(1)
      CIM(2) = S_CIM(2)
      CIM(3) = S_CIM(3)
      CIM(4) = S_CIM(4)
      CIM(5) = S_CIM(5)
      CIM(6) = S_CIM(6)
      CIM(7) = S_CIM(7)
      CIM(8) = S_CIM(8)
      CIM(9) = S_CIM(9)

C---------  Receive from ACSTHR and VCSTHR  -----------C

      CALL receive_REAL_32BIT( S_fxvcs )
      CALL receive_REAL_32BIT( S_fyvcs )
      CALL receive_REAL_32BIT( S_fzvcs )
      CALL receive_REAL_32BIT( S_fxacs )
      CALL receive_REAL_32BIT( S_fyacs )
      CALL receive_REAL_32BIT( S_fzacs )
      FXVCS = S_FXVCS
      FYVCS = S_FYVCS
      FZVCS = S_FZVCS
      FXACS = S_FXACS
      FYACS = S_FYACS
      FZACS = S_FZACS

      CALL SEND_REAL_32BIT( SNGL(UD) )
      CALL SEND_REAL_32BIT( SNGL(VD) )
      CALL SEND_REAL_32BIT( SNGL(WD) )

C-------------------------------------------------------------------------C
C----------------------------- OUTPUT MODULE -----------------------------C
C-------------------------------------------------------------------------C
C                              Creates print and plot output data         C
C                              files                                      C
C                                                                         C
C-------------------------------------------------------------------------C

      iprint = iprint + 1

      if (  iprint .eq. int(dtprt) ) then
         WRITE(MESSAGE,202) T,ALT,X,Y,Z
         CALL OUTMES(MESSAGE)
  202    FORMAT(1X, f8.4, 4E14.7)
         iprint = 0
      ENDIF

C-------------------------------------------------------------------------C
C---------------------------- TERMINATION LOGIC ----------------------------C
C-------------------------------------------------------------------------C
C                              Defines the simulation termination         C
C                              conditions                                 C
C                                                                         C
C-------------------------------------------------------------------------C

C     INITIALIZE SIMULATION EXIT FLAG TO ZERO ( PREVENTS EXIT )

      IEXIT  = 0

C     ENABLE EXIT IF MAXIMUM SIMULATION TIME HAS BEEN EXECUTED AND ALL
C     EVENTS SCHEDULED FOR THIS TIME HAVE BEEN EXECUTED

      IF ( T.GE.TFINAL ) THEN
         IEXIT  = 1
```

```
      ENDIF

C     ENABLE EXIT IF MISSILE HAS IMPACTED AND ALL EVENTS SCHEDULED FOR
C     THIS TIME HAVE BEEN EXECUTED

      IF ( ALT.LT.0.0 ) THEN
         IEXIT  = 1
      ENDIF

C     increment time

      TSTEP = TSTEP + 1.0D0
      T = TSTEP * DELT

C     CONTINUE LOOPING UNTIL ONE OR MORE EXIT CONDITIONS HAVE BEEN MET

      IF ( IEXIT.EQ.0 ) GO TO 1000


      CALL OUTMES('ERROR: Exit from P08')
      END
```

### B.1.10 Uup09.for

```
c      PROGRAM EXOSIM
C-------------------------------------------------------------------------C
C--------------- Declare and initialize variables  ---------------------C
C-------------------------------------------------------------------------C

      IMPLICIT REAL          (A-H)
      IMPLICIT REAL          (O-Z)

      CHARACTER*128 MESSAGE

      COMMON / NORCOM / GSET    , ISET
      COMMON / RANCOM /          RANSEQ(97),     RANLST

      REAL  MAGRTR        ,  snr
      REAL  LAMSEK(2)     ,  LAMM(2)
      real  gset, ranlst

      INTEGER            FRMCNT        ,  iset
      INTEGER            SEKTYP        ,  ACQD
      INTEGER            TERM          ,  TRACK
      INTEGER*4          SKSEED

      REAL TSTEP,DELT
      REAL TSPUDRIV,TSPUSTEP
      real delt_time
$INCLUDE(':pfp:INCLUDE/target.for')

* INITIALIZE 80x87
      CALL CW87

$INCLUDE('ssp09.dat')

C-------------------------------------------------------------------------C
C----------------------------- MAIN EXECUTION LOOP --------------------C
C-------------------------------------------------------------------------C
C                              Execution of all events is performed    C
C                              within this loop                        C
C                                                                      C
C-------------------------------------------------------------------------C

c     CALL INITIALIZE_TIMING()

 1000 CONTINUE

c     call reset_timer()
c      timer = read_timer()

c     CALL START_TIMING(0)

C     WRITE(*,*)'--------------BEGINNING OF LOOP-----------------'

C-------------------------------------------------------------------------C
C----------------------- Processor communication ----------------------C
C-------------------------------------------------------------------------C

c     CALL SWITCH_TIMING()

C----------------------- COMMUNICATION WITH KALMAN --------------------C


      call send_real_32bit( lamm(1) )
```

```
      call send_real_32bit( lamm(2) )
      call send_real_32bit( snr )
      call send_real_32bit( frmrat )

C---------------------- COMMUNICATION WITH RELAT ---------------------C

      CALL RECEIVE_REAL_32BIT( LAMSEK(01) )
      CALL RECEIVE_REAL_32BIT( LAMSEK(02) )
      CALL RECEIVE_REAL_32BIT( MAGRTR )


c     CALL SWITCH_TIMING()


C-----------------------------------------------------------------------C
C--------------------------- SEEKER MODULE -----------------------------C
C-----------------------------------------------------------------------C
C                             Calculates LOS angles measured by the     C
C                             seeker                                    C
C                                                                       C
C-----------------------------------------------------------------------C

      IF ( TSTEP .GE. TSPUDRIV ) THEN

c         TSPUDRIV = TSPUDRIV + TSPUSTEP


         CALL SEEKER(T,ACQD,LAMSEK,MAGRTR,SKSEED,FRMRAT,FRMCNT,
     .              SAMRAT,TRACK,TERM,SNR,LAMM)

         tspudriv = tspudriv + int(1000.0/frmrat)
      ENDIF

c     delt_time = (timer -(read_timer() + 18))/1.229e6
c     CALL output_message( %VAL(real_32bit), delt_time,
c    &     %VAL(int2(1)) )
c     call output_nl

C-----------------------------------------------------------------------C
C--------------------------- OUTPUT MODULE -----------------------------C
C-----------------------------------------------------------------------C

c        call stop_timing()

c     if (  mod(idnint(tstep),idnint(dtprt)).eq.0 ) then
c        call output_timing()
c        call INITIALIZE_TIMING()
c     ENDIF



C-----------------------------------------------------------------------C
C-------------------------- TERMINATION LOGIC --------------------------C
C-----------------------------------------------------------------------C
C                             Defines the simulation termination        C
C                             conditions                                C
C                                                                       C
C-----------------------------------------------------------------------C

C     INITIALIZE SIMULATION EXIT FLAG TO ZERO ( PREVENTS EXIT )

      IEXIT  = 0

C     increment time
```

```
      TSTEP = TSTEP + 1.0
      T = TSTEP * DELT

C     CONTINUE LOOPING UNTIL ONE OR MORE EXIT CONDITIONS HAVE BEEN MET

      IF ( IEXIT.EQ.0 ) GO TO 1000

      END
```

### B.1.11 Uup10.for

```
C     PROGRAM EXOSIM
C-----------------------------------------------------------------------C
C--------------- Declare and initialize variables  --------------------C
C-----------------------------------------------------------------------C

      IMPLICIT DOUBLE PRECISION         (A-H)
      IMPLICIT DOUBLE PRECISION         (O-Z)

      CHARACTER*128 MESSAGE
C     THE FOLLOWING COMMON BLOCKS USED FOR MIDFLIGHT CAPABILITIES ONLY

      COMMON / NORCOM / GSET   , ISET
      COMMON / RANCOM / RANSEQ , RANLST
      COMMON / RACCEL / DRSIGA , PSIA   , THTA   , PHIA   , THXZA ,
     .                  THXYA  , THYZA  , THYXA  , THZYA  , THZXA ,
     .                  SF1A   , SF2A   , DCA    , T0ACCE , GRLST ,
     .                  XYZDP  , ABI2   , ABI1   , ABO2   , ABO1

      REAL S_PD,S_QD,S_RD,S_UD,S_VD,S_WD,S_CIM(9)
      REAL S_CG(3),S_P,S_Q,S_R,S_XD,S_YD,S_ZD,S_GR(3)
      DOUBLE PRECISION  SF1A(3)      ,  SF2A(3)      ,  DCA(3)
      REAL              RANSEQ(97)   ,  RANLST
      DOUBLE PRECISION  GRLST(3)     ,  XYZDP(3)
      DOUBLE PRECISION  ABI2(3)      ,  ABI1(3)      ,  ABO2(3)
      DOUBLE PRECISION  ABO1(3)      ,  CIM(9)
      DOUBLE PRECISION  GR(3)        ,  PULSEA(3)
      DOUBLE PRECISION  QFRACA(3)    ,  CG(3)
      DOUBLE PRECISION  LONGLP, LATLP,  CIMO(9)

      INTEGER*4 GYSEED
      INTEGER   SEKTYP

      DOUBLE PRECISION TSTEP,DELT
      DOUBLE PRECISION TIMUDRIV,TIMUSTEP


* DATA INITIALIZATION

$include ('^/include/ssdata35.dat')
$include ('^/include/ssdata38.dat')
$include ('^/include/ssdata39.dat')
$include ('^/include/ssdata42.dat')
$include ('^/include/ssdata44.dat')
$include ('^/include/ssdata45.dat')
$include ('^/include/ssdata46.dat')
$include ('^/include/ssdata47.dat')
$include ('^/include/ssdata48.dat')
$include ('^/include/ssdata49.dat')
$include ('^/include/ssdata50.dat')
$include ('^/include/ssdata01.dat')
$include ('^/include/ssdata17.dat')
$include ('^/include/ssdata18.dat')
$include ('^/include/ssdata21.dat')
$include ('^/include/ssdata22.dat')
$include ('^/include/ssdata23.dat')
$include ('^/include/ssdata28.dat')
$include ('^/include/ssdata29.dat')
$include ('^/include/ssdata30.dat')
$include ('^/include/ssdata71.dat')
$include ('^/include/sstiming.dat')
```

```
        call cw87
$include ('ssp10.dat')


C-------------------------------------------------------------------------C
C----------------------------- MAIN EXECUTION LOOP -----------------------C
C-------------------------------------------------------------------------C
C                               Execution of all events is performed    C
C                               within this loop                        C
C                                                                       C
C-------------------------------------------------------------------------C


 1000 CONTINUE


C     WRITE(*,*)'--------------BEGINNING OF LOOP-----------------'

C-------------------------------------------------------------------------C
C----------------------- Processor communication -------------------------C
C-------------------------------------------------------------------------C
C-------------------  Communicate with p01 ---------------------------C

      CALL RECEIVE_REAL_32BIT( S_GR(1) )
      CALL RECEIVE_REAL_32BIT( S_GR(2) )
      CALL RECEIVE_REAL_32BIT( S_GR(3) )
      GR(1) = DBLE(S_GR(1))
      GR(2) = DBLE(S_GR(2))
      GR(3) = DBLE(S_GR(3))


      CALL SEND_REAL_32BIT( SNGL(PULSEA(01)) )
      CALL SEND_REAL_32BIT( SNGL(PULSEA(02)) )
      CALL SEND_REAL_32BIT( SNGL(PULSEA(03)) )

      CALL RECEIVE_REAL_32BIT( S_CG(1) )
      CALL RECEIVE_REAL_32BIT( S_CG(2) )
      CALL RECEIVE_REAL_32BIT( S_CG(3) )
      CG(1) = DBLE(S_CG(1))
      CG(2) = DBLE(S_CG(2))
      CG(3) = DBLE(S_CG(3))
      CALL RECEIVE_REAL_32BIT( S_P )
      CALL RECEIVE_REAL_32BIT( S_Q )
      CALL RECEIVE_REAL_32BIT( S_R )
      P = DBLE(S_P)
      Q = DBLE(S_Q)
      R = DBLE(S_R)

      CALL RECEIVE_REAL_32BIT( S_XD )
      CALL RECEIVE_REAL_32BIT( S_YD )
      CALL RECEIVE_REAL_32BIT( S_ZD )
      XD = DBLE(S_XD)
      YD = DBLE(S_YD)
      ZD = DBLE(S_ZD)

      CALL RECEIVE_REAL_32BIT( S_CIM(1) )
      CALL RECEIVE_REAL_32BIT( S_CIM(2) )
      CALL RECEIVE_REAL_32BIT( S_CIM(3) )
      CALL RECEIVE_REAL_32BIT( S_CIM(4) )
      CALL RECEIVE_REAL_32BIT( S_CIM(5) )
      CALL RECEIVE_REAL_32BIT( S_CIM(6) )
      CALL RECEIVE_REAL_32BIT( S_CIM(7) )
      CALL RECEIVE_REAL_32BIT( S_CIM(8) )
      CALL RECEIVE_REAL_32BIT( S_CIM(9) )
```

```
      CIM(1) = DBLE(S_CIM(1))
      CIM(2) = DBLE(S_CIM(2))
      CIM(3) = DBLE(S_CIM(3))
      CIM(4) = DBLE(S_CIM(4))
      CIM(5) = DBLE(S_CIM(5))
      CIM(6) = DBLE(S_CIM(6))
      CIM(7) = DBLE(S_CIM(7))
      CIM(8) = DBLE(S_CIM(8))
      CIM(9) = DBLE(S_CIM(9))

      CALL RECEIVE_REAL_32BIT( S_PD )
      CALL RECEIVE_REAL_32BIT( S_QD )
      CALL RECEIVE_REAL_32BIT( S_RD )
      CALL RECEIVE_REAL_32BIT( S_UD )
      CALL RECEIVE_REAL_32BIT( S_VD )
      CALL RECEIVE_REAL_32BIT( S_WD )
      PD = DBLE(S_PD)
      QD = DBLE(S_QD)
      RD = DBLE(S_RD)
      UD = DBLE(S_UD)
      VD = DBLE(S_VD)
      WD = DBLE(S_WD)


C-------------------------------------------------------------------------C
C----------------------------- INERTIAL MEASUREMENT UPDATE ---------------C
C-------------------------------------------------------------------------C
C                               Get inertial measurement data needed      C
C                               for guidance calculations .               C
C                                                                         C
C-------------------------------------------------------------------------C


      IF ( TSTEP .GE. TIMUDRIV ) THEN

         TIMUDRIV = TIMUDRIV + TIMUSTEP

C-------------------------------------------------------------------------C
C----------------------------- ACCELEROMETER MODULE ----------------------C
C-------------------------------------------------------------------------C
C                               Determine sensed accelerations            C
C                                                                         C
C-------------------------------------------------------------------------C


         CALL ACCEL(T,UD,VD,WD,P,Q,R,PD,QD,RD,CG,CIM,XD,YD,ZD,
     .              GR,GYSEED,QFRACA,PULSEA)

      ENDIF

C-------------------------------------------------------------------------C
C----------------------------- TERMINATION LOGIC -------------------------C
C-------------------------------------------------------------------------C
C                               Defines the simulation termination        C
C                               conditions                                C
C                                                                         C
C-------------------------------------------------------------------------C

C     INITIALIZE SIMULATION EXIT FLAG TO ZERO ( PREVENTS EXIT )

      IEXIT  = 0

C     increment time
```

```
      TSTEP = TSTEP + 1.0d0
      T = TSTEP * DELT

C     CONTINUE LOOPING UNTIL ONE OR MORE EXIT CONDITIONS HAVE BEEN MET

      IF ( IEXIT.EQ.0 ) GO TO 1000

      END
```

## B.1.12 Uup11.for

```
c      PROGRAM EXOSIM
C-------------------------------------------------------------------C
C--------------- Declare and initialize variables  -----------------C
C-------------------------------------------------------------------C

      IMPLICIT REAL          (A-H)
      IMPLICIT REAL          (O-Z)

      real rdum
      CHARACTER*128 MESSAGE
C     THE FOLLOWING COMMON BLOCKS USED FOR MIDFLIGHT CAPABILITIES ONLY

      COMMON / RMGUID / ISEQ    , TVCOMP , OMEGA0 , IMIDB2 , TMIDB2 ,
     .                  ISK3ON
      COMMON / RMAUTO / ANGACL , IMCPAS , TP2END , TP3END , IP2END ,
     .                  TCOAST , ICOAST , TRDONE , IRATE  , IACSB1 ,
     .                  IACSB2 , ICNT   , IVPFL  , IVPFLN , TBURN2 ,
     .                  OMEGAI , TLSTMA , AACCEL
      COMMON / RKVAUT / SW17   , SW18   , SW18P  , SW18Y  , SW19   ,
     .                  SW19P  , SW19Y  , IROLL  , TPTON2 , TYTON2 ,
     .                  TNEXTP , TNEXTY , FLTCPL , FLTCYL

      REAL T,TSTEP,DELT
      REAL TMSUDRIV,TIMUDRIV,TGPUDRIV,TAPUDRIV,TSPUDRIV,TKFUDRIV
      REAL TMSUSTEP,TIMUSTEP,TGPUSTEP,TAPUSTEP,TSPUSTEP,TKFUSTEP
      REAL FLTC(4)

      REAL dtacsa_s(4),dtacsb_s(4),dtoffv_s(4),tofflt_s(4)
      REAL  ANGACL(3,4,10)
      REAL  OMEGAI(3)     ,  GRLAST(3)
      REAL  OMEGA0(3)     ,  AACCEL(3,4)

      INTEGER           FIRST1       ,  FIRST2
      INTEGER           ISEQ(4)      ,  IMCPAS(3,4)   ,  FLIP

C     OUTPUTS

      REAL  MAGRTR       ,  MAGR         ,  MASS
      REAL  MAGV         ,  MGRDOT       ,  CMS(9)
      REAL  ADISTT(4,3)  ,  LAMDXX(2)
      REAL  LAMSEK(2)    ,  LAMM(2)
      REAL  RREL(3)      ,  URREL(3)
      REAL  VREL(3)      ,  TI2M(9)
      REAL  QS1(4)       ,  VMI(3)       ,  RMI(3)
      REAL   VTEST(3),  VMIR(3),  GRTEST(3)
      REAL  AT(3)
      REAL  CIE(9)

C     NAMELIST INPUTS

      REAL  IXX          ,  IYY          ,  IZZ
      REAL  CG(3)        ,  DTOFFV(4)    ,  VG(3)
      REAL  DTACSA(4)    ,  DTACSB(4)
      REAL  XYZE(3)      ,  XYZED(3)
      REAL  GRT(5,3)     ,  VTIC(5,3)    ,  rtic(5,3)
      REAL  PULSEA(3)    ,  PULSEG(3)
      REAL  LAM(2)       ,  LAMD(2)      ,  VGM(3)
      REAL  DTVCSP(3)    ,  DTVCSY(3)
      REAL  TOFFLT(4)    ,  LATLP        ,  LONGLP

      INTEGER           SEKTYP       ,  ACQD
```

```
      INTEGER           TERM          ,  TOSEED       ,ESTATE
      INTEGER           TRACK

      REAL   RTEST(3)             ,  RMIR(3)


* DATA INITIALIZATION
$INCLUDE('^/INCLUDE/SSDATA35.DAT')
$INCLUDE('^/INCLUDE/SSDATA38.DAT')
$INCLUDE('^/INCLUDE/SSDATA39.DAT')
$INCLUDE('^/INCLUDE/SSDATA42.DAT')
$INCLUDE('^/INCLUDE/SSDATA44.DAT')
$INCLUDE('^/INCLUDE/SSDATA45.DAT')
$INCLUDE('^/INCLUDE/SSDATA46.DAT')
$INCLUDE('^/INCLUDE/SSDATA47.DAT')
$INCLUDE('^/INCLUDE/SSDATA48.DAT')
$INCLUDE('^/INCLUDE/SSDATA49.DAT')
$INCLUDE('^/INCLUDE/SSDATA50.DAT')
$INCLUDE('^/INCLUDE/SSDATA01.DAT')
$INCLUDE('^/INCLUDE/SSDATA17.DAT')
$INCLUDE('^/INCLUDE/SSDATA18.DAT')
$INCLUDE('^/INCLUDE/SSDATA21.DAT')
$INCLUDE('^/INCLUDE/SSDATA22.DAT')
$INCLUDE('^/INCLUDE/SSDATA23.DAT')
$INCLUDE('^/INCLUDE/SSDATA28.DAT')
$INCLUDE('^/INCLUDE/SSDATA29.DAT')
$INCLUDE('^/INCLUDE/SSDATA30.DAT')
$INCLUDE('^/INCLUDE/SSDA1A71.DAT')
$INCLUDE('^/INCLUDE/SSTIMING.DAT')
$INCLUDE(':pfp:INCLUDE/target.for')

* INITIALIZE 80x87
      CALL CW87
$INCLUDE('SSp11.DAT')
               CALL MCAUTO(T,IXX,IYY,IZZ,SP,SQ,SR,ROLLER,PITER,
     .                   YAWER,IDIS. IACSON,IBURND,IBURNM,IDMEAS,IPASSM,
     .                         ICMD,TRATON,TPATON,TYATON,DTSAMP,TSAL,TSAH,
     .                         TLAPS,ITHRES,ANVP,ACSLEV,TMAUTO,0)

       idrop_s = idrop
       acslev_s = acslev
       dtacsa_s(1) = dtacsa(1)
       dtacsa_s(2) = dtacsa(2)
       dtacsa_s(3) = dtacsa(3)
       dtacsa_s(4) = dtacsa(4)
       dtacsb_s(1) = dtacsb(1)
       dtacsb_s(2) = dtacsb(2)
       dtacsb_s(3) = dtacsb(3)
       dtacsb_s(4) = dtacsb(4)
       dtoffv_s(1) = dtoffv(1)
       dtoffv_s(2) = dtoffv(2)
       dtoffv_s(3) = dtoffv(3)
       dtoffv_s(4) = dtoffv(4)
       ithres_s = ithres
       ivcs_s = ivcs
       ivtab_s = ivtab
       tatab_s = tatab
       tburnm_s = tburnm
       timonv_s = timonv
       tofflt_s(1) = tofflt(1)
       tofflt_s(2) = tofflt(2)
       tofflt_s(3) = tofflt(3)
       tofflt_s(4) = tofflt(4)
       tvtab_s = tvtab
```

```
C-------------------------------------------------------------------C
C------------------------- MAIN EXECUTION LOOP ---------------------C
C-------------------------------------------------------------------C
C                              Execution of all events is performed C
C                              within this loop                     C
C                                                                   C
C-------------------------------------------------------------------C

 1000 CONTINUE

C     WRITE(*,*)'--------------BEGINNING OF LOOP-----------------'

C-------------------------------------------------------------------C
C---------------------- Processor communication ---------------------C
C-------------------------------------------------------------------C


C----------------------- COMMUNICATION WITH P00 ----------------------C

      CALL RECEIVE_REAL_32BIT( IXX )
      CALL RECEIVE_REAL_32BIT( IYY )
      CALL RECEIVE_REAL_32BIT( IZZ )
      CALL RECEIVE_REAL_32BIT( MASS )

C----------------------- COMMUNICATION WITH P00 ----------------------C

      CALL SEND_SIGNED_16BIT( IDROP_s )
C----------------------- COMMUNICATION WITH P02 ----------------------C
      CALL SEND_REAL_32BIT( ACSLEV_s )
      CALL SEND_REAL_32BIT( DTACSA_s(01) )
      CALL SEND_REAL_32BIT( DTACSA_s(02) )
      CALL SEND_REAL_32BIT( DTACSA_s(03) )
      CALL SEND_REAL_32BIT( DTACSA_s(04) )
      CALL SEND_REAL_32BIT( DTACSB_s(01) )
      CALL SEND_REAL_32BIT( DTACSB_s(02) )
      CALL SEND_REAL_32BIT( DTACSB_s(03) )
      CALL SEND_REAL_32BIT( DTACSB_s(04) )
      CALL SEND_REAL_32BIT( DTOFFV_s(01) )
      CALL SEND_REAL_32BIT( DTOFFV_s(02) )
      CALL SEND_REAL_32BIT( DTOFFV_s(03) )
      CALL SEND_REAL_32BIT( DTOFFV_s(04) )
      CALL SEND_SIGNED_16BIT( ITHRES_s )
      CALL SEND_SIGNED_16BIT( IVCS_s )
      CALL SEND_SIGNED_16BIT( IVTAB_s )
      CALL SEND_REAL_32BIT( TATAB_s )
      CALL SEND_REAL_32BIT( TBURNM_s )
      CALL SEND_REAL_32BIT( TIMONV_s )
      CALL SEND_REAL_32BIT( TOFFLT_s(01) )
      CALL SEND_REAL_32BIT( TOFFLT_s(02) )
      CALL SEND_REAL_32BIT( TOFFLT_s(03) )
      CALL SEND_REAL_32BIT( TOFFLT_s(04) )
      CALL SEND_REAL_32BIT( TVTAB_s )

C----------------------- COMMUNICATION WITH P02 ----------------------C

      CALL RECEIVE_SIGNED_16BIT( IACSON )

C----------------- COMMUNICATE WITH CORVEL --------------C

      CALL RECEIVE_REAL_32BIT( VG(01) )
      CALL RECEIVE_REAL_32BIT( VG(02) )
      CALL RECEIVE_REAL_32BIT( VG(03) )

C---------------- DAISY CHAIN WITH IMUPRO AND NAVIG -----------------C
```

```
      CALL RECEIVE_REAL_32BIT( TI2M(1) )
      CALL RECEIVE_REAL_32BIT( TI2M(2) )
      CALL RECEIVE_REAL_32BIT( TI2M(3) )
      CALL RECEIVE_REAL_32BIT( TI2M(4) )
      CALL RECEIVE_REAL_32BIT( TI2M(5) )
      CALL RECEIVE_REAL_32BIT( TI2M(6) )
      CALL RECEIVE_REAL_32BIT( TI2M(7) )
      CALL RECEIVE_REAL_32BIT( TI2M(8) )
      CALL RECEIVE_REAL_32BIT( TI2M(9) )

      CALL RECEIVE_REAL_32BIT( VREL(1) )
      CALL RECEIVE_REAL_32BIT( VREL(2) )
      CALL RECEIVE_REAL_32BIT( VREL(3) )
      CALL RECEIVE_REAL_32BIT( RREL(1) )
      CALL RECEIVE_REAL_32BIT( RREL(2) )
      CALL RECEIVE_REAL_32BIT( RREL(3) )

      CALL RECEIVE_REAL_32BIT( SP )
      CALL RECEIVE_REAL_32BIT( SQ )
      CALL RECEIVE_REAL_32BIT( SR )

      call send_real_32bit( magr )
      call send_real_32bit( magv )
      call send_real_32bit( tgo )
      call send_real_32bit( piter )
      call send_real_32bit( roller )
      call send_real_32bit( yawer )
      call send_signed_16bit( iburn1 )
      call send_real_32bit( lamd(1) )
      call send_real_32bit( lamd(2) )
      call send_signed_16bit( acqd )

      call receive_signed_16bit( estate )
      call receive_real_32bit( piter )
      call receive_real_32bit( roller )
      call receive_real_32bit( yawer )
      call receive_signed_16bit( iburn1 )
      call receive_real_32bit( lamd(1) )
      call receive_real_32bit( lamd(2) )
      call receive_signed_16bit( acqd )
      call receive_real_32bit( tge1 )
      call receive_real_32bit( tge2a1 )
      call receive_real_32bit( trmtgo )


C-------------------------------------------------------------------------C
C                            ON BOARD GUIDANCE PROCESSING                 C
C-------------------------------------------------------------------------C
C                            Determine guidance commands                  C
C                                                                         C
C-------------------------------------------------------------------------C


      IF ( TSTEP .GE. TGPUDRIV ) THEN

C         TGPUDRIV = TGPUDRIV + TGPUSTEP

C-------------------------------------------------------------------------C
C--------------------------- ESTIMATED RELATIVE STATES MODULE --------C
C-------------------------------------------------------------------------C
C                            Estimate range, range rate, and time-to- C
C                            go based on navigation output and target C
```

```
C                              model estimates                                  C
C                                                                               C
C-------------------------------------------------------------------------------C


         CALL ESTREL(TI2M,CMS,ESTATE,RREL,VREL,
     .                MAGR,MAGV,URREL,MGRDOT,TGO,PITER,YAWER,LAMD)

      ENDIF

C-------------------------------------------------------------------------------C
C---------------------- Processor communication ---------------------------------C
C-------------------------------------------------------------------------------C


C----------------------- COMMUNICATION WITH P00 ----------------------C

      CALL RECEIVE_REAL_32BIT( IXX )
      CALL RECEIVE_REAL_32BIT( IYY )
      CALL RECEIVE_REAL_32BIT( IZZ )
      CALL RECEIVE_REAL_32BIT( MASS )

C----------------------- COMMUNICATION WITH P00 ----------------------C

      CALL SEND_SIGNED_16BIT( IDROP_s )
C----------------------- COMMUNICATION WITH P02 ----------------------C
      CALL SEND_REAL_32BIT( ACSLEV_s )
      CALL SEND_REAL_32BIT( DTACSA_s(01) )
      CALL SEND_REAL_32BIT( DTACSA_s(02) )
      CALL SEND_REAL_32BIT( DTACSA_s(03) )
      CALL SEND_REAL_32BIT( DTACSA_s(04) )
      CALL SEND_REAL_32BIT( DTACSB_s(01) )
      CALL SEND_REAL_32BIT( DTACSB_s(02) )
      CALL SEND_REAL_32BIT( DTACSB_s(03) )
      CALL SEND_REAL_32BIT( DTACSB_s(04) )
      CALL SEND_REAL_32BIT( DTOFFV_s(01) )
      CALL SEND_REAL_32BIT( DTOFFV_s(02) )
      CALL SEND_REAL_32BIT( DTOFFV_s(03) )
      CALL SEND_REAL_32BIT( DTOFFV_s(04) )
      CALL SEND_SIGNED_16BIT( ITHRES_s )
      CALL SEND_SIGNED_16BIT( IVCS_s )
      CALL SEND_SIGNED_16BIT( IVTAB_s )
      CALL SEND_REAL_32BIT( TATAB_s )
      CALL SEND_REAL_32BIT( TBURNM_s )
      CALL SEND_REAL_32BIT( TIMONV_s )
      CALL SEND_REAL_32BIT( TOFFLT_s(01) )
      CALL SEND_REAL_32BIT( TOFFLT_s(02) )
      CALL SEND_REAL_32BIT( TOFFLT_s(03) )
      CALL SEND_REAL_32BIT( TOFFLT_s(04) )
      CALL SEND_REAL_32BIT( TVTAB_s )

C----------------------- COMMUNICATION WITH P02 ----------------------C

      CALL RECEIVE_SIGNED_16BIT( IACSON )

C---------------- COMMUNICATE WITH CORVEL -------------C

      CALL RECEIVE_REAL_32BIT( VG(01) )
      CALL RECEIVE_REAL_32BIT( VG(02) )
      CALL RECEIVE_REAL_32BIT( VG(03) )

C---------------- DAISY CHAIN WITH IMUPRO AND NAVIG ------------------C

      CALL RECEIVE_REAL_32BIT( TI2M(1) )
```

```
      CALL RECEIVE_REAL_32BIT( TI2M(2) )
      CALL RECEIVE_REAL_32BIT( TI2M(3) )
      CALL RECEIVE_REAL_32BIT( TI2M(4) )
      CALL RECEIVE_REAL_32BIT( TI2M(5) )
      CALL RECEIVE_REAL_32BIT( TI2M(6) )
      CALL RECEIVE_REAL_32BIT( TI2M(7) )
      CALL RECEIVE_REAL_32BIT( TI2M(8) )
      CALL RECEIVE_REAL_32BIT( TI2M(9) )

      CALL RECEIVE_REAL_32BIT( VREL(1) )
      CALL RECEIVE_REAL_32BIT( VREL(2) )
      CALL RECEIVE_REAL_32BIT( VREL(3) )
      CALL RECEIVE_REAL_32BIT( RREL(1) )
      CALL RECEIVE_REAL_32BIT( RREL(2) )
      CALL RECEIVE_REAL_32BIT( RREL(3) )

      CALL RECEIVE_REAL_32BIT( SP )
      CALL RECEIVE_REAL_32BIT( SQ )
      CALL RECEIVE_REAL_32BIT( SR )


C-------------------------------------------------------------------------C
C---------------------------- MISSILE STATE UPDATE MODULE ----------------C
C-------------------------------------------------------------------------C
C                              Integrate missile states to current time   C
C                                                                         C
C-------------------------------------------------------------------------C


C-------------------------------------------------------------------------C
C------------------------------ VCS THRUSTER RESPONSE MODULE -------------C
C-------------------------------------------------------------------------C
C                               Determines the forces and moments         C
C                               imparted by the VCS thrusters             C
C                                                                         C
C-------------------------------------------------------------------------C


      IF ( T.GE.TKVON ) THEN

         CALL VCSTHR2(T,FLTC,FLTCP,FLTCY,TBURNM,TOFFLT,
     .                c..onv,IVTAB)


C-------------------------------------------------------------------------C
C------------------------------ ACS THRUSTER RESPONSE MODULE -------------C
C-------------------------------------------------------------------------C
C                               Determines the forces and moments         C
C                               imparted by the ACS thrusters             C
C                                                                         C
C-------------------------------------------------------------------------C


         CALL ACSTHR2(ITHRES)

      ENDIF


C-------------------------------------------------------------------------C
C------------------------------ SEPARATION MODULE ------------------------C
C-------------------------------------------------------------------------C
C                               Models discontinuities occuring during    C
C                               stage separation                          C
C                                                                         C
```

```
C-----------------------------------------------------------------C


C        NOSE FAIRING / BOOST ADAPTER SEPARATION

         IF ( IDROP.EQ.1 .OR. (ABS(T-TDROP).LE.DTEPS
     *                .AND. IGIT.EQ.1 ) ) THEN
            IDROP  = 2
            IPASSM = 0
          ENDIF


       IF ( TSTEP .GE. TGPUDRIV ) THEN

          TGPUDRIV = TGPUDRIV + TGPUSTEP

C-----------------------------------------------------------------C
C------------------------- MIDCOURSE GUIDANCE MODULE -------------C
C-----------------------------------------------------------------C
C                              Calculates roll error, controls    C
C                              midcourse sequencing, and issues   C
C                              midcourse diverts                  c
C-----------------------------------------------------------------C

          IF ( T.GT.TSTG2 .AND.
     *         T.GE.TMGUID .AND. ACQD.EQ.0 ) THEN

            CALL MCGUID(T,TI2M,VG,URREL,MASS,IDIST,MIDBRN,MAGR,
     .           MAGV,SP,SQ,SR,PITER,YAWER,FLIP,IVCS,ICMD,IDMEAS,IDPASS,
     .                 IDROP,IMCEND,IBURND,IBURNM,VGM,ADISTT,ROLLER,
     .                 TMGUID)

          ENDIF

       ENDIF

C-----------------------------------------------------------------C
C--------------------------- KALMAN FILTER MODULE ----------------C
C-----------------------------------------------------------------C
       call send_real_32bit( magr )
       call send_real_32bit( magv )
       call send_real_32bit( tgo )
       call send_real_32bit( piter )
       call send_real_32bit( roller )
       call send_real_32bit( yawer )
       call send_signed_16bit( iburn1 )
       call send_real_32bit( lamd(1) )
       call send_real_32bit( lamd(2) )
       call send_signed_16bit( acqd )

       call receive_signed_16bit( estate )
       call receive_real_32bit( piter )
       call receive_real_32bit( roller )
       call receive_real_32bit( yawer )
       call receive_signed_16bit( iburn1 )
       call receive_real_32bit( lamd(1) )
       call receive_real_32bit( lamd(2) )
       call receive_signed_16bit( acqd )
       call receive_real_32bit( tge1 )
       call receive_real_32bit( tge2a1 )
       call receive_real_32bit( trmtgo )

C-----------------------------------------------------------------C
```

```
C---------------------- Processor communication ----------------------C
C---------------------------------------------------------------------C


C----------------------- COMMUNICATION WITH P00 ----------------------C

      CALL RECEIVE_REAL_32BIT( IXX )
      CALL RECEIVE_REAL_32BIT( IYY )
      CALL RECEIVE_REAL_32BIT( IZZ )
      CALL RECEIVE_REAL_32BIT( MASS )

C----------------------- COMMUNICATION WITH P00 ----------------------C

      CALL SEND_SIGNED_16BIT( IDROP_s )
C----------------------- COMMUNICATION WITH P02 ----------------------C
      CALL SEND_REAL_32BIT( ACSLEV_s )
      CALL SEND_REAL_32BIT( DTACSA_s(01) )
      CALL SEND_REAL_32BIT( DTACSA_s(02) )
      CALL SEND_REAL_32BIT( DTACSA_s(03) )
      CALL SEND_REAL_32BIT( DTACSA_s(04) )
      CALL SEND_REAL_32BIT( DTACSB_s(01) )
      CALL SEND_REAL_32BIT( DTACSB_s(02) )
      CALL SEND_REAL_32BIT( DTACSB_s(03) )
      CALL SEND_REAL_32BIT( DTACSB_s(04) )
      CALL SEND_REAL_32BIT( DTOFFV_s(01) )
      CALL SEND_REAL_32BIT( DTOFFV_s(02) )
      CALL SEND_REAL_32BIT( DTOFFV_s(03) )
      CALL SEND_REAL_32BIT( DTOFFV_s(04) )
      CALL SEND_SIGNED_16BIT( ITHRES_s )
      CALL SEND_SIGNED_16BIT( IVCS_s )
      CALL SEND_SIGNED_16BIT( IVTAB_s )
      CALL SEND_REAL_32BIT( TATAB_s )
      CALL SEND_REAL_32BIT( TBURNM_s )
      CALL SEND_REAL_32BIT( TIMONV_s )
      CALL SEND_REAL_32BIT( TOFFLT_s(01) )
      CALL SEND_REAL_32BIT( TOFFLT_s(02) )
      CALL SEND_REAL_32BIT( TOFFLT_s(03) )
      CALL SEND_REAL_32BIT( TOFFLT_s(04) )
      CALL SEND_REAL_32BIT( TVTAB_s )

C----------------------- COMMUNICATION WITH P02 ----------------------C

      CALL RECEIVE_SIGNED_16BIT( IACSON )

C---------------- COMMUNICATE WITH CORVEL --------------C

      CALL RECEIVE_REAL_32BIT( VG(01) )
      CALL RECEIVE_REAL_32BIT( VG(02) )
      CALL RECEIVE_REAL_32BIT( VG(03) )

C---------------- DAISY CHAIN WITH IMUPRO AND NAVIG ------------------C

      CALL RECEIVE_REAL_32BIT( TI2M(1) )
      CALL RECEIVE_REAL_32BIT( TI2M(2) )
      CALL RECEIVE_REAL_32BIT( TI2M(3) )
      CALL RECEIVE_REAL_32BIT( TI2M(4) )
      CALL RECEIVE_REAL_32BIT( TI2M(5) )
      CALL RECEIVE_REAL_32BIT( TI2M(6) )
      CALL RECEIVE_REAL_32BIT( TI2M(7) )
      CALL RECEIVE_REAL_32BIT( TI2M(8) )
      CALL RECEIVE_REAL_32BIT( TI2M(9) )

      CALL RECEIVE_REAL_32BIT( VREL(1) )
      CALL RECEIVE_REAL_32BIT( VREL(2) )
```

```
      CALL RECEIVE_REAL_32BIT( VREL(3) )
      CALL RECEIVE_REAL_32BIT( RREL(1) )
      CALL RECEIVE_REAL_32BIT( RREL(2) )
      CALL RECEIVE_REAL_32BIT( RREL(3) )

      CALL RECEIVE_REAL_32BIT( SP )
      CALL RECEIVE_REAL_32BIT( SQ )
      CALL RECEIVE_REAL_32BIT( SR )

      call send_real_32bit( magr )
      call send_real_32bit( magv )
      call send_real_32bit( tgo )
      call send_real_32bit( piter )
      call send_real_32bit( roller )
      call send_real_32bit( yawer )
      call send_signed_16bit( iburn1 )
      call send_real_32bit( lamd(1) )
      call send_real_32bit( lamd(2) )
      call send_signed_16bit( acqd )

      call receive_signed_16bit( estate )
      call receive_real_32bit( piter )
      call receive_real_32bit( roller )
      call receive_real_32bit( yawer )
      call receive_signed_16bit( iburn1 )
      call receive_real_32bit( lamd(1) )
      call receive_real_32bit( lamd(2) )
      call receive_signed_16bit( acqd )
      call receive_real_32bit( tge1 )
      call receive_real_32bit( tge2a1 )
      call receive_real_32bit( trmtgo )

C-------------------------------------------------------------------------C
C------------------------------ AUTOPILOTS -------------------------------C
C-------------------------------------------------------------------------C
C                                                                         C
C-------------------------------------------------------------------------C

      IF ( TSTEP .GE. TAPUDRIV ) THEN


C-------------------------------------------------------------------------C
C---------------------- MIDCOURSE AUTOPILOT MODULE -----------------------C
C-------------------------------------------------------------------------C
C                             Performs large angle reorients and rate   C
C                             control during midcourse                  C
C-------------------------------------------------------------------------C


         IF ( T.GE.TKVON ) THEN

            IF ( T.GT.TSTG2 .AND. T.GE.TMAUTO .AND.
     .                              ( ICMD.NE.0 .OR. ACQD.EQ.0) ) THEN

               CALL MCAUTO(T,IXX,IYY,IZZ,SP,SQ,SR,ROLLER,PITER,
     .                     YAWER,IDIST,IACSON,IBURND,IBURNM,IDMEAS,IPASSM,
     .                          ICMD,TRATON,TPATON,TYATON,DTSAMP,TSAL,TSAH,
     .                          TLAPS,ITHRES,ANVP,ACSLEV,TMAUTO,1)

            ENDIF
         ENDIF
      ENDIF
C-------------------------------------------------------------------------C
C----------------------- Processor communication -------------------------C
```

```
C-------------------------------------------------------------------------C

      idrop_s = idrop
C----------------------- COMMUNICATION WITH P00 ----------------------C

      CALL RECEIVE_REAL_32BIT( IXX )
      CALL RECEIVE_REAL_32BIT( IYY )
      CALL RECEIVE_REAL_32BIT( IZZ )
      CALL RECEIVE_REAL_32BIT( MASS )

C----------------------- COMMUNICATION WITH P00 ----------------------C

      CALL SEND_SIGNED_16BIT( IDROP_s )
C----------------------- COMMUNICATION WITH P02 ----------------------C
      CALL SEND_REAL_32BIT( ACSLEV_s )
      CALL SEND_REAL_32BIT( DTACSA_s(01) )
      CALL SEND_REAL_32BIT( DTACSA_s(02) )
      CALL SEND_REAL_32BIT( DTACSA_s(03) )
      CALL SEND_REAL_32BIT( DTACSA_s(04) )
      CALL SEND_REAL_32BIT( DTACSB_s(01) )
      CALL SEND_REAL_32BIT( DTACSB_s(02) )
      CALL SEND_REAL_32BIT( DTACSB_s(03) )
      CALL SEND_REAL_32BIT( DTACSB_s(04) )
      CALL SEND_REAL_32BIT( DTOFFV_s(01) )
      CALL SEND_REAL_32BIT( DTOFFV_s(02) )
      CALL SEND_REAL_32BIT( DTOFFV_s(03) )
      CALL SEND_REAL_32BIT( DTOFFV_s(04) )
      CALL SEND_SIGNED_16BIT( ITHRES_s )
      CALL SEND_SIGNED_16BIT( IVCS_s )
      CALL SEND_SIGNED_16BIT( IVTAB_s )
      CALL SEND_REAL_32BIT( TATAB_s )
      CALL SEND_REAL_32BIT( TBURNM_s )
      CALL SEND_REAL_32BIT( TIMONV_s )
      CALL SEND_REAL_32BIT( TOFFLT_s(01) )
      CALL SEND_REAL_32BIT( TOFFLT_s(02) )
      CALL SEND_REAL_32BIT( TOFFLT_s(03) )
      CALL SEND_REAL_32BIT( TOFFLT_s(04) )
      CALL SEND_REAL_32BIT( TVTAB_s )

C----------------------- COMMUNICATION WITH P02 ----------------------C

      CALL RECEIVE_SIGNED_16BIT( IACSON )

C---------------- COMMUNICATE WITH CORVEL -------------C

      CALL RECEIVE_REAL_32BIT( VG(01) )
      CALL RECEIVE_REAL_32BIT( VG(02) )
      CALL RECEIVE_REAL_32BIT( VG(03) )

C---------------- DAISY CHAIN WITH IMUPRO AND NAVIG -------------------C

      CALL RECEIVE_REAL_32BIT( TI2M(1) )
      CALL RECEIVE_REAL_32BIT( TI2M(2) )
      CALL RECEIVE_REAL_32BIT( TI2M(3) )
      CALL RECEIVE_REAL_32BIT( TI2M(4) )
      CALL RECEIVE_REAL_32BIT( TI2M(5) )
      CALL RECEIVE_REAL_32BIT( TI2M(6) )
      CALL RECEIVE_REAL_32BIT( TI2M(7) )
      CALL RECEIVE_REAL_32BIT( TI2M(8) )
      CALL RECEIVE_REAL_32BIT( TI2M(9) )

      CALL RECEIVE_REAL_32BIT( VREL(1) )
      CALL RECEIVE_REAL_32BIT( VREL(2) )
      CALL RECEIVE_REAL_32BIT( VREL(3) )
```

```
      CALL RECEIVE_REAL_32BIT( RREL(1) )
      CALL RECEIVE_REAL_32BIT( RREL(2) )
      CALL RECEIVE_REAL_32BIT( RREL(3) )

      CALL RECEIVE_REAL_32BIT( SP )
      CALL RECEIVE_REAL_32BIT( SQ )
      CALL RECEIVE_REAL_32BIT( SR )

      call send_real_32bit( magr )
      call send_real_32bit( magv )
      call send_real_32bit( tgo )
      call send_real_32bit( piter )
      call send_real_32bit( roller )
      call send_real_32bit( yawer )
      call send_signed_16bit( iburn1 )
      call send_real_32bit( lamd(1) )
      call send_real_32bit( lamd(2) )
      call send_signed_16bit( acqd )

      call receive_signed_16bit( estate )
      call receive_real_32bit( piter )
      call receive_real_32bit( roller )
      call receive_real_32bit( yawer )
      call receive_signed_16bit( iburn1 )
      call receive_real_32bit( lamd(1) )
      call receive_real_32bit( lamd(2) )
      call receive_signed_16bit( acqd )
      call receive_real_32bit( tge1 )
      call receive_real_32bit( tge2a1 )
      call receive_real_32bit( trmtgo )

C-------------------------------------------------------------------------C
C------------------------------ AUTOPILOTS -------------------------------C
C-------------------------------------------------------------------------C
C                                                                         C
C-------------------------------------------------------------------------C

      IF ( TSTEP .GE. TAPUDRIV ) THEN

         IF ( T.GE.TKVON ) THEN

C-------------------------------------------------------------------------C
C---------------------------- KV AUTOPILOT MODULE -------------------------C
C-------------------------------------------------------------------------C
C                             Calls the various ACS autopilot             C
C                             modes used for controlling the              C
C                             kill vehicle attitude during flight.        C
C                             Its purpose is to define which              C
C                             thruster to burn, for how long, and at      C
C                             what thrust level.                          C
C                                                                         C
C-------------------------------------------------------------------------C


            CALL KVAUTO(T,SP,SQ,SR,FLTCP,FLTCY,IXX,IYY,IZZ,ADISTT,
     .                  ROLLER,PITER,YAWER,TCWAIT,IDIST,SW80,TSAL,TSAH,
     .                  TNEXT,TLAPS,ANVP,DTSAMP,ACSLEV,TRATON,TPATON,
     .                  TYATON,ITHRES)

         ENDIF
      ENDIF

C---------------------- COMMUNICATION WITH P00 ---------------------------C
```

```
      CALL RECEIVE_REAL_32BIT( IXX )
      CALL RECEIVE_REAL_32BIT( IYY )
      CALL RECEIVE_REAL_32BIT( IZZ )
      CALL RECEIVE_REAL_32BIT( MASS )

C---------------------- COMMUNICATION WITH P00 ----------------------C

      CALL SEND_SIGNED_16BIT( IDROP_s )
C---------------------- COMMUNICATION WITH P02 ----------------------C
      CALL SEND_REAL_32BIT( ACSLEV_s )
      CALL SEND_REAL_32BIT( DTACSA_s(01) )
      CALL SEND_REAL_32BIT( DTACSA_s(02) )
      CALL SEND_REAL_32BIT( DTACSA_s(03) )
      CALL SEND_REAL_32BIT( DTACSA_s(04) )
      CALL SEND_REAL_32BIT( DTACSB_s(01) )
      CALL SEND_REAL_32BIT( DTACSB_s(02) )
      CALL SEND_REAL_32BIT( DTACSB_s(03) )
      CALL SEND_REAL_32BIT( DTACSB_s(04) )
      CALL SEND_REAL_32BIT( DTOFFV_s(01) )
      CALL SEND_REAL_32BIT( DTOFFV_s(02) )
      CALL SEND_REAL_32BIT( DTOFFV_s(03) )
      CALL SEND_REAL_32BIT( DTOFFV_s(04) )
      CALL SEND_SIGNED_16BIT( ITHRES_s )
      CALL SEND_SIGNED_16BIT( IVCS_s )
      CALL SEND_SIGNED_16BIT( IVTAB_s )
      CALL SEND_REAL_32BIT( TATAB_s )
      CALL SEND_REAL_32BIT( TBURNM_s )
      CALL SEND_REAL_32BIT( TIMONV_s )
      CALL SEND_REAL_32BIT( TOFFLT_s(01) )
      CALL SEND_REAL_32BIT( TOFFLT_s(02) )
      CALL SEND_REAL_32BIT( TOFFLT_s(03) )
      CALL SEND_REAL_32BIT( TOFFLT_s(04) )
      CALL SEND_REAL_32BIT( TVTAB_s )

C---------------------- COMMUNICATION WITH P02 ----------------------C

      CALL RECEIVE_SIGNED_16BIT( IACSON )

C---------------- COMMUNICATE WITH CORVEL --------------C

      CALL RECEIVE_REAL_32BIT( VG(01) )
      CALL RECEIVE_REAL_32BIT( VG(02) )
      CALL RECEIVE_REAL_32BIT( VG(03) )

C---------------- DAISY CHAIN WITH IMUPRO AND NAVIG -------------------C

      CALL RECEIVE_REAL_32BIT( TI2M(1) )
      CALL RECEIVE_REAL_32BIT( TI2M(2) )
      CALL RECEIVE_REAL_32BIT( TI2M(3) )
      CALL RECEIVE_REAL_32BIT( TI2M(4) )
      CALL RECEIVE_REAL_32BIT( TI2M(5) )
      CALL RECEIVE_REAL_32BIT( TI2M(6) )
      CALL RECEIVE_REAL_32BIT( TI2M(7) )
      CALL RECEIVE_REAL_32BIT( TI2M(8) )
      CALL RECEIVE_REAL_32BIT( TI2M(9) )

      CALL RECEIVE_REAL_32BIT( VREL(1) )
      CALL RECEIVE_REAL_32BIT( VREL(2) )
      CALL RECEIVE_REAL_32BIT( VREL(3) )
      CALL RECEIVE_REAL_32BIT( RREL(1) )
      CALL RECEIVE_REAL_32BIT( RREL(2) )
      CALL RECEIVE_REAL_32BIT( RREL(3) )
```

```
      CALL RECEIVE_REAL_32BIT( SP )
      CALL RECEIVE_REAL_32BIT( SQ )
      CALL RECEIVE_REAL_32BIT( SR )

      call send_real_32bit( magr )
      call send_real_32bit( magv )
      call send_real_32bit( tgo )
      call send_real_32bit( piter )
      call send_real_32bit( roller )
      call send_real_32bit( yawer )
      call send_signed_16bit( iburn1 )
      call send_real_32bit( lamd(1) )
      call send_real_32bit( lamd(2) )
      call send_signed_16bit( acqd )

      call receive_signed_16bit( estate )
      call receive_real_32bit( piter )
      call receive_real_32bit( roller )
      call receive_real_32bit( yawer )
      call receive_signed_16bit( iburn1 )
      call receive_real_32bit( lamd(1) )
      call receive_real_32bit( lamd(2) )
      call receive_signed_16bit( acqd )
      call receive_real_32bit( tge1 )
      call receive_real_32bit( tge2al )
      call receive_real_32bit( trmtgo )
C-------------------------------------------------------------------C
C------------------------------ AUTOPILOTS -------------------------C
C-------------------------------------------------------------------C
C                                                                   C
C-------------------------------------------------------------------C
      IF ( TSTEP .GE. TAPUDRIV ) THEN

         TAPUDRIV = TAPUDRIV + TAPUSTEP

         IF ( T.GE.TKVON ) THEN

C-------------------------------------------------------------------C
C---------------------------- VCS LOGIC MODULE ---------------------C
C-------------------------------------------------------------------C
C                             Controls the kill vehicle velocity by C
C                             determining the appropriate VCS thruster C
C                             on and off times.                     C
C                                                                   C
C-------------------------------------------------------------------C


            CALL VCSLOG(T,MASS,LAMD,TGO,MAGV,TGIL,TRMTGO,TGE2AL,
     .              TGE1,VGM,IVCS,IDMEAS,IBURNM,MIDBRN,IBURN1,IBURN2,
     .                   IBURN3,IDIST,FLTC,FLTCP,FLTCY,TSAL,TSAH,TOFFLT,
     .                   TOFLTM,TBURNP,TBURNY,TGE2,TGI1P,TGI2P,TGI3P,
     .                   TGI1Y,TGI2Y,TGI3Y,TIMONV,TGOFLM,TCWAIT,DTVCSP,
     .                   DTVCSY,DTOFFV,TBURNM)

C            SET FLAG TO COMPUTE VCS THRUSTER RESPONSE TABLE

            IVTAB = 1
            TVTAB = T

C-------------------------------------------------------------------C
C---------------------------- ACS RESOLVING LOGIC MODULE -----------C
C-------------------------------------------------------------------C
C                                                                   C
```

```
            IF ( ITHRES.EQ.1 ) THEN

               CALL RESTHR(T,IDIST,ANVP,DTSAMP,TOFLTM,TRATON,
                           TPATON,TYATON,DTACSA,DTACSB)

C              BEGINNING TIME OF ACS THRUSTER RESPONSE TABLE

               TATAB = T

            ENDIF

         ENDIF

      ENDIF

      ithres_s = ithres
      acslev_s = acslev

      dtacsa_s(1) = dtacsa(1)
      dtacsa_s(2) = dtacsa(2)
      dtacsa_s(3) = dtacsa(3)
      dtacsa_s(4) = dtacsa(4)
      dtacsb_s(1) = dtacsb(1)
      dtacsb_s(2) = dtacsb(2)
      dtacsb_s(3) = dtacsb(3)
      dtacsb_s(4) = dtacsb(4)
      dtoffv_s(1) = dtoffv(1)
      dtoffv_s(2) = dtoffv(2)
      dtoffv_s(3) = dtoffv(3)
      dtoffv_s(4) = dtoffv(4)
      ivcs_s = ivcs
      ivtab_s = ivtab
      tatab_s = tatab
      tburnm_s = tburnm
      timonv_s = timonv
      tofflt_s(1) = tofflt(1)
      tofflt_s(2) = tofflt(2)
      tofflt_s(3) = tofflt(3)
      tofflt_s(4) = tofflt(4)
      tvtab_s = tvtab

C-------------------------------------------------------------------------C
C----------------------------- TERMINATION LOGIC -------------------------C
C-------------------------------------------------------------------------C
C                              Defines the simulation termination       C
C                              conditions                               C
C                                                                       C
C-------------------------------------------------------------------------C

C     INITIALIZE SIMULATION EXIT FLAG TO ZERO ( PREVENTS EXIT )

      IEXIT  = 0

C     ENABLE EXIT IF MAXIMUM SIMULATION TIME HAS BEEN EXECUTED AND ALL
C     EVENTS SCHEDULED FOR THIS TIME HAVE BEEN EXECUTED

      IF ( T.GE.TFINAL ) THEN
         IEXIT  = 1
      ENDIF

C     increment time

      TSTEP = TSTEP + 5.0E0
```

```
      T = TSTEP * DELT
C     CONTINUE LOOPING UNTIL ONE OR MORE EXIT CONDITIONS HAVE BEEN MET
      IF ( IEXIT.EQ.0 ) GO TO 1000
      END
```

## B.1.13 Uup12.for

```
c      PROGRAM EXOSIM
C-------------------------------------------------------------------------C
C--------------- Declare and initialize variables  ---------------------C
C-------------------------------------------------------------------------C

      IMPLICIT REAL          (A-H)
      IMPLICIT REAL          (O-Z)

      real rdum
      CHARACTER*128 MESSAGE
C     THE FOLLOWING COMMON BLOCKS USED FOR MIDFLIGHT CAPABILITIFS ONLY

      COMMON / RKALMN / TKF     , IDRTOK , PP11    , PP12    , PP22    ,
     .                  PY11    , PY12   , PY22    , PLMDFP , YLMDFP ,
     .                  PLAMH   , YLAMH  , PLAMDH , YLAMDH , PLAMDF ,
     .                  YLAMDF , TGIL    , KFMODE , IFPAS

      REAL T,TSTEP,DELT
      REAL TMSUDRIV,TIMUDRIV,TGPUDRIV,TAPUDRIV,TSPUDRIV,TKFUDRIV
      REAL TMSUSTEP,TIMUSTEP,TGPUSTEP,TAPUSTEP,TSPUSTEP,TKFUSTEP
      REAL FLTC(4)

      REAL dtacsa_s(4),dtacsb_s(4),dtoffv_s(4),tofflt_s(4)
      REAL  ANGACL(3,4,10)
      REAL  OMEGAI(3)     ,  GRLAST(3)
      REAL  OMEGA0(3)     ,  AACCEL(3,4)

      INTEGER           FIRST1       ,  FIRST2
      INTEGER           ISEQ(4)      ,  IMCPAS(3,4)   ,  FLIP

C     OUTPUTS

      REAL  MAGRTR        ,  MAGR          ,  MASS
      REAL  MAGV          ,  MGRDOT        ,  CMS(9)
      REAL  ADISTT(4,3)   ,  LAMDXX(2)
      REAL  LAMSEK(2)     ,  LAMM(2)
      REAL  RREL(3)       ,  URREL(3)
      REAL  VREL(3)       ,  TI2M(9)
      REAL  QS1(4)        ,  VMI(3)        ,  RMI(3)
      REAL   VTEST(3),  VMIR(3),  GRTEST(3)
      REAL  AT(3)
      REAL  CIE(9)

C     NAMELIST INPUTS

      REAL  IXX           ,  IYY           ,  IZZ
      REAL  CG(3)         ,  DTOFFV(4)     ,  VG(3)
      REAL  DTACSA(4)     ,  DTACSB(4)
      REAL  XYZE(3)       ,  XYZED(3)
      REAL  GRT(5,3)      ,  VTIC(5,3)     ,  rtic(5,3)
      REAL  PULSEA(3)     ,  PULSEG(3)
      REAL  LAM(2)        ,  LAMD(2)       ,  VGM(3)
      REAL  DTVCSP(3)     ,  DTVCSY(3)
      REAL  TOFFLT(4)     ,  LATLP         ,  LONGLP

      INTEGER           SEKTYP       ,  ACQD
      INTEGER           TERM         ,  TOSEED       ,ESTATE
      INTEGER           TRACK

      REAL   RTEST(3)           ,  RMIR(3)
```

```
* DATA INITIALIZATION
$INCLUDE('^/INCLUDE/SSDATA35.DAT')
$INCLUDE('^/INCLUDE/SSDATA38.DAT')
$INCLUDE('^/INCLUDE/SSDATA39.DAT')
$INCLUDE('^/INCLUDE/SSDATA42.DAT')
$INCLUDE('^/INCLUDE/SSDATA44.DAT')
$INCLUDE('^/INCLUDE/SSDATA45.DAT')
$INCLUDE('^/INCLUDE/SSDATA46.DAT')
$INCLUDE('^/INCLUDE/SSDATA47.DAT')
$INCLUDE('^/INCLUDE/SSDATA48.DAT')
$INCLUDE('^/INCLUDE/SSDATA49.DAT')
$INCLUDE('^/INCLUDE/SSDATA50.DAT')
$INCLUDE('^/INCLUDE/SSDATA01.DAT')
$INCLUDE('^/INCLUDE/SSDATA17.DAT')
$INCLUDE('^/INCLUDE/SSDATA18.DAT')
$INCLUDE('^/INCLUDE/SSDATA21.DAT')
$INCLUDE('^/INCLUDE/SSDATA22.DAT')
$INCLUDE('^/INCLUDE/SSDATA23.DAT')
$INCLUDE('^/INCLUDE/SSDATA28.DAT')
$INCLUDE('^/INCLUDE/SSDATA29.DAT')
$INCLUDE('^/INCLUDE/SSDATA30.DAT')
$INCLUDE('^/INCLUDE/SSDATA71.DAT')
$INCLUDE('^/INCLUDE/SSTIMING.DAT')
$INCLUDE(':pfp:INCLUDE/target.for')

* INITIALIZE 80x87
      CALL CW87

$INCLUDE('SS_12.DAT')

      idrop_s = idrop
      acslev_s = acslev
      dtacsa_s(1) = dtacsa(1)
      dtacsa_s(2) = dtacsa(2)
      dtacsa_s(3) = dtacsa(3)
      dtacsa_s(4) = dtacsa(4)
      dtacsb_s(1) = dtacsb(1)
      dtacsb_s(2) = dtacsb(2)
      dtacsb_s(3) = dtacsb(3)
      dtacsb_s(4) = dtacsb(4)
      dtoffv_s(1) = dtoffv(1)
      dtoffv_s(2) = dtoffv(2)
      dtoffv_s(3) = dtoffv(3)
      dtoffv_s(4) = dtoffv(4)
      ithres_s = ithres
      ivcs_s = ivcs
      ivtab_s = ivtab
      tatab_s = tatab
      tburnm_s = tburnm
      timonv_s = timonv
      tofflt_s(1) = tofflt(1)
      tofflt_s(2) = tofflt(2)
      tofflt_s(3) = tofflt(3)
      tofflt_s(4) = tofflt(4)
      tvtab_s = tvtab
C-------------------------------------------------------------------------C
C------------------------------ MAIN EXECUTION LOOP ----------------------C
C-------------------------------------------------------------------------C
C                              Execution of all events is performed       C
C                              within this loop                           C
C                                                                         C
C-------------------------------------------------------------------------C
```

```
 1000 CONTINUE

C     WRITE(*,*)'--------------BEGINNING OF LOOP-----------------'

C-------------------------------------------------------------------------C
C---------------------- Processor communication ----------------------C
C-------------------------------------------------------------------------C

C---------------------- COMMUNICATION WITH SEEKER --------------------C

      call receive_real_32bit( lamm(1) )
      call receive_real_32bit( lamm(2) )
      call receive_real_32bit( snr )
      call receive_real_32bit( frmrat )

C---------------------- COMMUNICATION WITH P03 -----------------------C

      CALL RECEIVE_SIGNED_16BIT( IRESLV )
      CALL RECEIVE_REAL_32BIT( LAMDXX(01) )
      CALL RECEIVE_REAL_32BIT( LAMDXX(02) )
      call receive_real_32bit( lamsek(1) )
      call receive_real_32bit( lamsek(2) )
      call receive_real_32bit( magrtr )

C---------------- DAISY CHAIN WITH IMUPRO AND NAVIG -------------------C

      CALL RECEIVE_REAL_32BIT( TI2M(1) )
      CALL RECEIVE_REAL_32BIT( TI2M(2) )
      CALL RECEIVE_REAL_32BIT( TI2M(3) )
      CALL RECEIVE_REAL_32BIT( TI2M(4) )
      CALL RECEIVE_REAL_32BIT( TI2M(5) )
      CALL RECEIVE_REAL_32BIT( TI2M(6) )
      CALL RECEIVE_REAL_32BIT( TI2M(7) )
      CALL RECEIVE_REAL_32BIT( TI2M(8) )
      CALL RECEIVE_REAL_32BIT( TI2M(9) )

      CALL RECEIVE_REAL_32BIT( VREL(1) )
      CALL RECEIVE_REAL_32BIT( VREL(2) )
      CALL RECEIVE_REAL_32BIT( VREL(3) )
      CALL RECEIVE_REAL_32BIT( RREL(1) )
      CALL RECEIVE_REAL_32BIT( RREL(2) )
      CALL RECEIVE_REAL_32BIT( RREL(3) )


C-------------------------------------------------------------------------C
C---------------------------- KALMAN FILTER MODULE -----------------------C
C-------------------------------------------------------------------------C
C                            Filter LOS angles                            C
C                                                                         C
C-------------------------------------------------------------------------C
      call receive_real_32bit( magr )
      call receive_real_32bit( magv )
      call receive_real_32bit( tgo )
      call receive_real_32bit( piter )
      call receive_real_32bit( roller )
      call receive_real_32bit( yawer )
      call receive_signed_16bit( iburn1 )
      call receive_real_32bit( lamd(1) )
      call receive_real_32bit( lamd(2) )
      call receive_signed_16bit( acqd )

      IF ( TSTEP .GE. TKFUDRIV ) THEN
```

```
c          TKFUDRIV = TKFUDRIV + TKFUSTEP
          TKFUDRIV = TKFUDRIV + int(1000.0/frmrat)

c          write(message,103)t
c103       format(' kalman',f10.4)
c          call outmes(message)

C         CALL FILTER IF SNR IS SUFFICIENT

          IF ( SNR.GE.SNRACQ .OR. SEKTYP.NE.2 ) THEN

             IF (SEKTYP.EQ.1 .OR. SEKTYP.EQ.2) THEN
                ASIG = (32.56*SNR**(-0.29912))*1.0E-6
             ENDIF

             CALL KALMAN(T,TI2M,LAMM,ASIG,SNR,TGO,RREL,VREL,
     .            TI2M,RACQ,MAGRTR,MAGR,MAGV,LAMSEK,LAMDXX,FRMRAT,CMS,
     .                 MACQ,MCSO,MTERM,IRESLV,TRACK,TERM,TRMTGO,TGE1,
     .                 TGE2AL,WFILT,ZFILT,LAM,LAMD,IBURN1,ACQD,ESTATE,
     .                 PITER,YAWER,ROLLER)

          ENDIF
        ENDIF

        call send_signed_16bit( estate )
        call send_real_32bit( piter )
        call send_real_32bit( roller )
        call send_real_32bit( yawer )
        call send_signed_16bit( iburn1 )
        call send_real_32bit( lamd(1) )
        call send_real_32bit( lamd(2) )
        call send_signed_16bit( acqd )
        call send_real_32bit( tge1 )
        call send_real_32bit( tge2al )
        call send_real_32bit( trmtgo )

C-------------------------------------------------------------------------C
C----------------------------- TERMINATION LOGIC -------------------------C
C-------------------------------------------------------------------------C
C                               Defines the simulation termination        C
C                               conditions                                C
C                                                                         C
C-------------------------------------------------------------------------C

C       INITIALIZE SIMULATION EXIT FLAG TO ZERO ( PREVENTS EXIT )

        IEXIT  = 0

C       ENABLE EXIT IF MAXIMUM SIMULATION TIME HAS BEEN EXECUTED AND ALL
C       EVENTS SCHEDULED FOR THIS TIME HAVE BEEN EXECUTED

        IF ( T.GE.TFINAL ) THEN
           IEXIT  = 1
        ENDIF

C       increment time

        TSTEP = TSTEP + 1.0E0
        T = TSTEP * DELT

C       CONTINUE LOOPING UNTIL ONE OR MORE EXIT CONDITIONS HAVE BEEN MET

        IF ( IEXIT.EQ.0 ) GO TO 1000
```

```
END
```

## B.2 Utilities (FORTRAN)

### B.2.1 Sskvauto.for

Omitted - Classified

## B.2.2 Ssvcslog.for

```
Omitted - Classified
```

### B.2.3 Uaccel.for

```
C-------------------------------------------------------------------- ---
      SUBROUTINE ACCEL(T,UD,VD,WD,P,Q,R,PD,QD,RD,CG,CIM,XD,YD,ZD,GR,
     .                 GYSEED,QFRACA,PULSEA)
C-----------------------------------------------------------------------
C
C     SUBROUTINE NAME :      ACCEL
C
C     AUTHOR(S) :            D. C. FOREMAN
C
C     FUNCTION :             ACCELEROMETER MODEL COMPUTES SENSED DELTA
C                            VELOCITY COUNTS.  INCLUDES ROTATIONAL
C                            EFFECTS, AXIS MISALIGNMENT AND NONORTHOGON-
C                            ALITY ERRORS, SCALE FACTOR ERRORS, RANDOM
C                            AND CONSTANT DRIFT AND QUANTIZATION.
C
C     CALLED FROM :          FORTRAN MAIN
C
C     SUBROUTINES CALLED :   NORM    , RESP2R
C
C     INPUTS :               T,UD,VD,WD,P,Q,R,PD,QD,RD,CG,CIM,XD,
C                            YD,ZD,GR
C
C     OUTPUTS :              NONE
C
C     BOTH :                 GYSEED,QFRACA,PULSEA
C
C     UPDATES :              T. THORNTON - CR # 004
C                            T. THORNTON - CR # 016
C                            B. HILL     - CR # 020
C                            D. SMITH    - CR # 021
C                            B. HILL     - CR # 022
C                            B. HILL     - CR # 030
C                            T. THORNTON - CR # 037
C                            B. HILL     - CR # 038
C                            D. SMITH    - CR # 059
C                            D. SISSOM   - CR # 069
C                            D. SMITH    - CR # 070
C                            D. SMITH    - CR # 075
C                            D. SMITH    - CR # 076
C                            B. HILL /   - CR # 081
C                            R. RHYNE
C                            R. RHYNE    - CR # 084
C                            R. RHYNE    - CR # 087
C                            B. HILL     - CR # 093
C
C-----------------------------------------------------------------------

      IMPLICIT DOUBLE PRECISION          (A-H)
      IMPLICIT DOUBLE PRECISION          (O-Z)

      DOUBLE PRECISION  ABI0(3)        , ABI1(3)        , ABI2(3)
      DOUBLE PRECISION  ABO0(3)        , ABO1(3)        , ABO2(3)
      DOUBLE PRECISION  CG(3)          , CIM(9)         , DCA(3)
      DOUBLE PRECISION  DUM1(3)        , DUM2(3)        , DUM3(3)
      DOUBLE PRECISION  DVEL(3)        , GR(3)          , GRAVG(3)
      DOUBLE PRECISION  GRLST(3)       , LIMU(3)        , PULSEA(3)
      DOUBLE PRECISION  QFRACA(3)      , SF1A(3)        , SF2A(3)
      DOUBLE PRECISION  SFEA(3)        , WDRA(3)
      DOUBLE PRECISION  XIMU(3)        , XYZDP(3)
```

```
      INTEGER*4           GYSEED

C     LOCAL COMMON USED FOR CONSTANTS,LOCAL VARIABLES AND
C     INITIALIZATION FLAG

      SAVE                IACCEL

C     COMMON "RACCEL" USED FOR MIDFLIGHT CAPABILITIES ONLY

      COMMON / RACCEL / DRSIGA, PSIA   , THTA   , PHIA   , THXZA ,
     .                  THXYA , THYZA  , THYXA  , THZYA  , THZXA ,
     .                  SF1A  , SF2A   , DCA    , T0ACCE , GRLST ,
     .                  XYZDP , ABI2   , ABI1   , ABO2   , ABO1

* DATA INITIALIZATION
$include('^/include/ssdata15.dat')
$include('^/include/ssdata16.dat')

      DATA IACCEL / 1 /

      IF (IACCEL .EQ. 1) THEN

         IACCEL = 0

C        INITIALIZE ACCELEROMETER PARAMETERS

         IF ( T .EQ. 0.0 ) THEN
            DRSIGA = DRSGAI/(60.0*DSQRT(DTIMU))
            CALL NORM(ALNSGA,ALNMNA,GYSEED,PSIA)
            CALL NORM(ALNSGA,ALNMNA,GYSEED,THTA)
            CALL NORM(ALNSGA,ALNMNA,GYSEED,PHIA)
            CALL NORM(AORSGA,AORMNA,GYSEED,THXZA)
            CALL NORM(AORSGA,AORMNA,GYSEED,THXYA)
            CALL NORM(AORSGA,AORMNA,GYSEED,THYZA)
            CALL NORM(AORSGA,AORMNA,GYSEED,THYXA)
            CALL NORM(AORSGA,AORMNA,GYSEED,THZYA)
            CALL NORM(AORSGA,AORMNA,GYSEED,THZXA)
            CALL NORM(SF1SGA,SF1MNA,GYSEED,SF1A(1))
            CALL NORM(SF1SGA,SF1MNA,GYSEED,SF1A(2))
            CALL NORM(SF1SGA,SF1MNA,GYSEED,SF1A(3))
            CALL NORM(SF2SGA,SF2MNA,GYSEED,SF2A(1))
            CALL NORM(SF2SGA,SF2MNA,GYSEED,SF2A(2))
            CALL NORM(SF2SGA,SF2MNA,GYSEED,SF2A(3))
            CALL NORM(DCSIGA,DCMENA,GYSEED,DCA(1))
            CALL NORM(DCSIGA,DCMENA,GYSEED,DCA(2))
            CALL NORM(DCSIGA,DCMENA,GYSEED,DCA(3))
            DO 10 I = 1,3
               ABI2(I) = 0.0D0
               ABI1(I) = 0.0D0
               ABO2(I) = 0.0D0
               ABO1(I) = 0.0D0
   10       CONTINUE
         ENDIF

C     COMPUTE SECOND ORDER RESPONSE DIFFERENCE EQUATION COEFFICIENTS

         IF ( IARTYP.EQ.2 ) THEN
            CALL RESP2R ( DTIMU,WACC,ZACC,CABI2,CABI1,CABI0,CABO2,
     .                    CABO1,CABO0 )
         ENDIF
      ENDIF

C     CALCULATE TIME SINCE LAST CALL TO ACCEL
```

```
      DTDEL  = T - T0ACCE
      T0ACCE = T

C     DETERMINE INERTIAL FRAME DELTA VELOCITY OVER PREVIOUS INTERVAL
WITH
C     GRAVITIONAL CONTRIBUTION REMOVED

      IF ( DTDEL.NE.0.0D0 ) THEN
         GRAVG(1) = 0.5D0 * ( GR(1) + GRLST(1) )
         GRAVG(2) = 0.5D0 * ( GR(2) + GRLST(2) )
         GRAVG(3) = 0.5D0 * ( GR(3) + GRLST(3) )
         DLVXI    = XD - XYZDP(1) - DTDEL*GRAVG(1)
         DLVYI    = YD - XYZDP(2) - DTDEL*GRAVG(2)
         DLVZI    = ZD - XYZDP(3) - DTDEL*GRAVG(3)
      ENDIF

C     SAVE GRAVITY VECTOR FOR USE ON NEXT PASS

      GRLST(1) = GR(1)
      GRLST(2) = GR(2)
      GRLST(3) = GR(3)

C     ROTATE DELTA VELOCITY INTO MISSILE FRAME

      IF ( DTDEL.NE.0.0D0 ) THEN
         DLVXB  = CIM(1)*DLVXI + CIM(4)*DLVYI + CIM(7)*DLVZI
         DLVYB  = CIM(2)*DLVXI + CIM(5)*DLVYI + CIM(8)*DLVZI
         DLVZB  = CIM(3)*DLVXI + CIM(6)*DLVYI + CIM(9)*DLVZI
      ENDIF

C     CONVERT DELTA VELOCITY TO AVERAGE ACCELERATION

      IF ( DTDEL.NE.0.0D0 ) THEN
         UDAVG  = DLVXB / DTDEL
         VDAVG  = DLVYB / DTDEL
         WDAVG  = DLVZB / DTDEL
      ELSE
         UDAVG  = UD
         VDAVG  = VD
         WDAVG  = WD
      ENDIF

C     SAVE PREVIOUS INERTIAL FRAME VELOCITY

      XYZDP(1) = XD
      XYZDP(2) = YD
      XYZDP(3) = ZD

C     SENSOR ACCELERATION DUE TO PACKAGE OFFSET FROM THE CG

      IF ( IMUOFF.EQ.0 ) THEN
         UDR    = UDAVG
         VDR    = VDAVG
         WDR    = WDAVG
      ELSE
         XIMU(1) = CG(1) - LIMU(1)
         XIMU(2) = CG(2) - LIMU(2)
         XIMU(3) = CG(3) - LIMU(3)

         DUM1(1) = QD*XIMU(3) - RD*XIMU(2)
         DUM1(2) = RD*XIMU(1) - PD*XIMU(3)
         DUM1(3) = PD*XIMU(2) - QD*XIMU(1)

         DUM2(1) = Q*XIMU(3) - R*XIMU(2)
```

```
            DUM2(2) = R*XIMU(1) - P*XIMU(3)
            DUM2(3) = P*XIMU(2) - Q*XIMU(1)

            DUM3(1) = Q*DUM2(3) - R*DUM2(2)
            DUM3(2) = R*DUM2(1) - P*DUM2(3)
            DUM3(3) = P*DUM2(2) - Q*DUM2(1)

            UDR     = UDAVG + DUM1(1) + DUM3(1)
            VDR     = VDAVG + DUM1(2) + DUM3(2)
            WDR     = WDAVG + DUM1(3) + DUM3(3)
         ENDIF

C        ACCELEROMETER AXIS MISALIGNMENT EFFECTS

         UDM    =   UDR      + VDR*PSIA - WDR*THTA
         VDM    = - UDR*PSIA + VDR      + WDR*PHIA
         WDM    =   UDR*THTA - VDR*PHIA + WDR

C        ACCELEROMETER AXIS NONORTHOGONALITY EFFECTS

         UDN    =   UDM       + VDM*THXZA - WDM*THXYA
         VDN    = - UDM*THYZA + VDM       + WDM*THYXA
         WDN    =   UDM*THZYA - VDM*THZXA + WDM

C        ADD LINEAR AND QUADRATIC SCALE FACTOR ERRORS

         SFEA(1) = UDN + SF1A(1)*UDN + SF2A(1)*UDN**2
         SFEA(2) = VDN + SF1A(2)*VDN + SF2A(2)*VDN**2
         SFEA(3) = WDN + SF1A(3)*WDN + SF2A(3)*WDN**2

C        FOR EACH AXIS ...

         DO 20 I=1,3

C           MAKE A GAUSSIAN DRAW FOR RANDOM DRIFT AND ADD TO CONSTANT DRIFT

            IF ( DRSIGA.GT.0.0D0 ) THEN
               CALL NORM(DRSIGA,DRMENA,GYSEED,DRA)
            ENDIF

            WDRA(I) = DRA + DCA(I)

C           COMPUTE INPUT TO ACCELEROMETER RESPONSE MODEL

            ABI0(I) = SFEA(I) + WDRA(I)

C           SECOND ORDER RESPONSE MODEL

            IF ( IARTYP.EQ.2 ) THEN
               ABO0(I) = ( CABI0*ABI0(I) + CABI1*ABI1(I)
     .                   + CABI2*ABI2(I) - CABO1*ABO1(I)
     .                   - CABO2*ABO2(I) )/CABO0
               ABI2(I) = ABI1(I)
               ABI1(I) = ABI0(I)
               ABO2(I) = ABO1(I)
               ABO1(I) = ABO0(I)
            ENDIF

C           INSTANTANEOUS RESPONSE MODEL

            IF ( IARTYP.EQ.0 ) THEN
               ABO0(I) = ABI0(I)
            ENDIF
```

```
C         COMPUTE SENSED DELTA VELOCITY

          DVEL(I) = DTDEL * ABOO(I)

          IF ( SPPA.GT.0.0 ) THEN

C            UNQUANTIZED OUTPUT IN COUNTS

             QFRACA(I) = QFRACA(I) - PULSEA(I) + DVEL(I)/SPPA

C            QUANTIZED OUTPUT IN COUNTS

             PULSEA(I) = DINT(QFRACA(I))

          ELSE
             PULSEA(I) = DVEL(I)
          ENDIF

    20 CONTINUE

       RETURN
       END
```

## B.2.4 Uuacsth2.for

```
C-----------------------------------------------------------------------
      SUBROUTINE ACSTHR2(ITHRES)
C-----------------------------------------------------------------------
C
C     SUBROUTINE NAME :      ACSTHR2
C
C     AUTHOR  ) :            B. HILL
C
C     FUNCTION  :            RESOLVES THE ACS THRUSTER BURN TIMES INTO
C                            THE APPROPRIATE FORCES AND MOMENTS
C
C     CALLED FROM  :         FORTRAN MAIN
C
C     SUBROUTINES CALLED :   none
C
C     BOTH :                 ITHRES
C
C     UPDATES :              D. SISSOM    - CR # 017
C                            D. SISSOM    - CR # 032
C                            B. HILL      - CR # 038
C                            T. THORNTON  - CR # 043
C                            B. HILL      - CR # 051
C                            D. SMITH     - CR # 059
C                            D. SISSOM    - CR # 069
C                            D. SMITH     - CR # 074
C                            D. SMITH     - CR # 076
C                            D. SMITH     - CR # 080
C                            B. HILL /    - CR # 081
C                            R. RHYNE
C                            D. SMITH     - CR # 082
C                            R. RHYNE     - CR # 083
C                            R. RHYNE     - CR # 084
C                            B. HILL      - CR # 086
C                            R. RHYNE     - CR # 087
C                            B. HILL      - CR # 089
C                            B. HILL      - CR # 093
C
C-----------------------------------------------------------------------

      IMPLICIT REAL          (A-H)
      IMPLICIT REAL          (O-Z)



      IF (ITHRES .EQ. 1) THEN

         ITHRES = 0

      ENDIF

      RETURN
      END
```

## B.2.5 Uuacsthr.for

```
C-----------------------------------------------------------------------
      SUBROUTINE ACSTHR(T,CG,ACSLEV,DTACSA,DTACSB,TATAB,TOSEED,TBRK,
     .                  ITHRES,FXACS,FYACS,FZACS,MXACS,MYACS,MZACS,
     .                  MDOTA,IACSON,TIMONA)
C-----------------------------------------------------------------------
C
C     SUBROUTINE NAME :      ACSTHR
C
C     AUTHOR(S) :            B. HILL
C
C     FUNCTION  :            RESOLVES THE ACS THRUSTER BURN TIMES INTO
C                            THE APPROPRIATE FORCES AND MOMENTS
C
C     CALLED FROM  :         FORTRAN MAIN
C
C     SUBROUTINES CALLED :   NORM,TABLE
C
C     INPUTS :               T,CG,ACSLEV,DTACSA,DTACSB,TATAB
C
C     OUTPUTS :              FXACS,FYACS,FZACS,MXACS,MYACS,MZACS,MDOTA,
C                            IACSON,TIMONA
C
C     BOTH :                 TOSEED,TBRK,ITHRES
C
C     UPDATES :              D. SISSOM   - CR # 017
C                            D. SISSOM   - CR # 032
C                            B. HILL     - CR # 038
C                            T. THORNTON - CR # 043
C                            B. HILL     - CR # 051
C                            D. SMITH    - CR # 059
C                            D. SISSOM   - CR # 069
C                            D. SMITH    - CR # 074
C                            D. SMITH    - CR # 076
C                            D. SMITH    - CR # 080
C                            B. HILL /   - CR # 081
C                            R. RHYNE
C                            D. SMITH    - CR # 082
C                            R. RHYNE    - CR # 083
C                            R. RHYNE    - CR # 084
C                            B. HILL     - CR # 086
C                            R. RHYNE    - CR # 087
C                            B. HILL     - CR # 089
C                            B. HILL     - CR # 093
C
C-----------------------------------------------------------------------

      IMPLICIT REAL          (A-H)
      IMPLICIT REAL          (O-Z)

      REAL  ACSDIR(3,4)    , ACSLOC(3,4)    , ACSMA(9,4)
      REAL  AOFF1(4)       , AOFF2(4)       , ATHRA(4)
      REAL  ATHRB(4)       , CG(3)          , DTACSA(4)
      REAL  DTACSB(4)      , F(3)           , F0(3)
      REAL  ISPACS         , M(3)           , MDOTA
      REAL  MXACS          , MYACS          , MZACS
      REAL  THACSA(8,4)    , THACSB(8,4)    , TMACSA(8,4)
      REAL  TMACSB(8,4)    , XMOM(3)

      INTEGER           INDXA(4)
      INTEGER           INDXB(4)
      INTEGER           LENA(4)       , LENB(4)
```

```
      INTEGER*4          TOSEED

C     LOCAL COMMON USED FOR CONSTANTS, LOCAL VARIABLES AND
C     INITIALIZATION FLAG

      SAVE               IACSTH , ACSMA

C     COMMON "RACSTR" USED FOR MIDFLIGHT CAPABILITIES ONLY

      COMMON / RACSTR / TREFLA , TLSTC  , ACSF   , AOFF1  , AOFF2  ,
     .                  TMACSA , THACSA , LENA   , TMACSB , THACSB ,
     .                  LENB

* DATA INITIALIZATION
$INCLUDE('^/INCLUDE/SSDATA01.DAT')
$INCLUDE('^/INCLUDE/SSDATA02.DAT')
$INCLUDE('^/INCLUDE/SSDATA03.DAT')
$INCLUDE('^/INCLUDE/SSDATA17.DAT')
$INCLUDE('^/INCLUDE/SSDATA18.DAT')
$INCLUDE('^/INCLUDE/SSDATA19.DAT')
$INCLUDE('^/INCLUDE/SSDATA20.DAT')

      DATA IACSTH / 1 /

      IF ( IACSTH.EQ.1 ) THEN

         IACSTH = 0

         IF (T .LT. TKVON+EPSL) THEN

C           ACS MISALIGNMENT DIRECTIONS
C           AOFF1 = CONE ANGLE OFF NORMAL
C           AOFF2 = POLAR ANGLE

            CALL spNORM(AOFFSD,0.0e0,TOSEED,AOFF1(1))
            CALL spNORM(AOFFSD,0.0e0,TOSEED,AOFF1(2))
            CALL spNORM(AOFFSD,0.0e0,TOSEED,AOFF1(3))
            CALL spNORM(AOFFSD,0.0e0,TOSEED,AOFF1(4))

            AOFF2(1) = 2.0*PI*spRAN0(TOSEED)
            AOFF2(2) = 2.0*PI*spRAN0(TOSEED)
            AOFF2(3) = 2.0*PI*spRAN0(TOSEED)
            AOFF2(4) = 2.0*PI*spRAN0(TOSEED)

         ENDIF

         DO 300 I = 1 , 4
            CAOFF1 = COS(AOFF1(I))
            SAOFF1 = SIN(AOFF1(I))
            CAOFF2 = COS(AOFF2(I))
            SAOFF2 = SIN(AOFF2(I))
            ACSMA(1,I) = CAOFF1
            ACSMA(2,I) = SAOFF1*CAOFF2
            ACSMA(3,I) = SAOFF1*SAOFF2
            ACSMA(4,I) = SAOFF1*SAOFF2
            ACSMA(5,I) = CAOFF1
            ACSMA(6,I) = SAOFF1*CAOFF2
            ACSMA(7,I) = SAOFF1*CAOFF2
            ACSMA(8,I) = SAOFF1*SAOFF2
            ACSMA(9,I) = CAOFF1
  300    CONTINUE

      ENDIF
```

```
C     RESET THE FORCE AND MOMENT COUNTERS TO ZERO

      FXACS  = 0.0
      FYACS  = 0.0
      FZACS  = 0.0
      MXACS  = 0.0
      MYACS  = 0.0
      MZACS  = 0.0
      MDOTA  = 0.0

      IF (ITHRES .EQ. 1) THEN

C        CALCULATE TIME FOR PULSE TO COME ON AND TIME FOR PULSE TO
C        REACH FULL FORCE LEVEL

         TIMONA = TATAB + TLAGA
         TUPA = TIMONA + TRUPA

C        DETERMINE APPROPRIATE MAXIMUM THRUST LEVEL

         IF (ACSLEV .GT. 1.5) THEN
            ACSF = ACSFH
         ELSE
            ACSF = ACSFL
         ENDIF
C
         DO 101 I=1,4

C           INITIALIZE TABLE POINTERS

            INDXA(I) = 1
            INDXB(I) = 1

C           CALCULATE THRUSTER RESPONSE TABLE FOR "A" THRUSTERS

            CALL spTABLE(TMACSA(1,I),THACSA(1,I),TATAB,THA1,LENA(I),
     .                   INDXA(I))
            IF (DTACSA(I) .GE. TCMINA) THEN
               IF (THA1 .LT. EPSL) THEN

C                 PREVIOUS VALVE STATE WAS LOW

                  TMACSA(1,I) = TATAB
                  THACSA(1,I) = 0.0
                  TMACSA(2,I) = TIMONA
                  THACSA(2,I) = 0.0
                  TMACSA(3,I) = TUPA
                  THACSA(3,I) = ACSF
                  IPTR = 4
               ELSE
                  CALL spTABLE(TMACSA(1,I),THACSA(1,I),TIMONA,THA2,
     .                         LENA(I),INDXA(I))
                  IF (THA2 .LT. EPSL) THEN

C                    PREVIOUS VALVE STATE WAS EITHER DELAY OR RAMP,
C                    AND NO CROSS-OVER IS PRESENT

                     TMACSA(1,I) = TMACSA(LENA(I)-3,I)
                     THACSA(1,I) = THACSA(LENA(I)-3,I)
                     TMACSA(2,I) = TMACSA(LENA(I)-2,I)
                     THACSA(2,I) = THACSA(LENA(I)-2,I)
                     TMACSA(3,I) = TMACSA(LENA(I)-1,I)
                     THACSA(3,I) = THACSA(LENA(I)-1,I)
                     TMACSA(4,I) = TIMONA
```

```
                  THACSA(4,I) = 0.0
                  TMACSA(5,I) = TUPA
                  THACSA(5,I) = ACSF
                  IPTR = 6
               ELSE
                  CALL spTABLE(TMACSA(1,I),THACSA(1,I),TUPA,THA3,
     .                        LENA(I),INDXA(I))
                  IF (THA3 .GE. (ACSF-EPSL)) THEN

C                    PREVIOUS VALVE STATE WAS HIGH

                     TMACSA(1,I) = TATAB
                     THACSA(1,I) = ACSF
                     IPTR = 2
                  ELSE

C                    PREVIOUS VALVE STATE WAS DELAY, AND A
C                    CROSS-OVER CONDITION HAS OCCURED

                     TMACSA(1,I) = TMACSA(LENA(I)-3,I)
                     THACSA(1,I) = THACSA(LENA(I)-3,I)
                     TMACSA(2,I) = TMACSA(LENA(I)-2,I)
                     THACSA(2,I) = THACSA(LENA(I)-2,I)
                     TMACSA(3,I) = (TMACSA(LENA(I)-1,I) + TIMONA)/2.0
                     THACSA(3,I) = (TMACSA(3,I) - TIMONA)*ACSF/TRDNA
                     TMACSA(4,I) = TUPA
                     THACSA(4,I) = ACSF
                     IPTR = 5
                  ENDIF
               ENDIF
               TMACSA(IPTR,I) = TIMONA + DTACSA(I)
               THACSA(IPTR,I) = ACSF
               TMACSA(IPTR+1,I) = TMACSA(IPTR,I) + TRDNA
               THACSA(IPTR+1,I) = 0.0
               TMACSA(IPTR+2,I) = 999.0
               THACSA(IPTR+2,I) = 0.0
               LENA(I) = IPTR+2
            ELSE

C              MAKE SURE VALVE IS OFF

               IF (THA1 .LT. EPSL) THEN

C                 PREVIOUS VALVE STATE WAS LOW

                  TMACSA(1,I) = TATAB
                  THACSA(1,I) = 0.0
                  TMACSA(2,I) = 999.0
                  THACSA(2,I) = 0.0
                  LENA(I) = 2
               ELSE
                  CALL spTABLE(TMACSA(1,I),THACSA(1,I),TUPA,THA3,
     .                        LENA(I),INDXA(I))
                  IF (THA3 .LT. EPSL) THEN

C                    PREVIOUS VALVE STATE WAS EITHER DELAY OR RAMP, WITH
C                    NO CROSSOVER POSSIBLE

                     TMACSA(1,I) = TMACSA(LENA(I)-3,I)
                     THACSA(1,I) = THACSA(LENA(I)-3,I)
                     TMACSA(2,I) = TMACSA(LENA(I)-2,I)
                     THACSA(2,I) = THACSA(LENA(I)-2,I)
                     TMACSA(3,I) = TMACSA(LENA(I)-1,I)
```

```
                  THACSA(3,I) = THACSA(LENA(I)-1,I)
                  TMACSA(4,I) = 999.0
                  THACSA(4,I) = 0.0
                  LENA(I) = 4
               ELSE

C                 PREVIOUS VALVE STATE WAS DELAY, AND CROSSOVER COULD
C                 OCCUR

                  TMACSA(1,I) = TATAB
                  THACSA(1,I) = ACSF
                  TMACSA(2,I) = TIMONA
                  THACSA(2,I) = ACSF
                  TMACSA(3,I) = TIMONA + TRDNA
                  THACSA(3,I) = 0.0
                  TMACSA(4,I) = 999.0
                  THACSA(4,I) = 0.0
                  LENA(I) = 4
               ENDIF
            ENDIF
         END1F

C        CALCULATE THRUSTER RESPONSE TABLE FOR "B" THRUSTERS

         CALL spTABLE(TMACSB(1,I),THACSB(1,I),TATAB,THB1,LENB(I),
     .              INDXB(I))
         IF (DTACSB(I) .GE. TCMINA) THEN
            IF (THB1 .LT. EPSL) THEN

C              PREVIOUS VALVE STATE WAS LOW

               TMACSB(1,I) = TATAB
               THACSB(1,I) = 0.0
               TMACSB(2,I) = TIMONA
               THACSB(2,I) = 0.0
               TMACSB(3,I) = TUPA
               THACSB(3,I) = ACSF
               IPTR = 4
            ELSE
               CALL spTABLE(TMACSB(1,I),THACSB(1,I),TIMONA,THB2,
     .                    LENB(I),INDXB(I))
               IF (THB2 .LT. EPSL) THEN

C                 PREVIOUS VALVE STATE WAS EITHER DELAY OR RAMP,
C                 AND NO CROSS-OVER IS PRESENT

                  TMACSB(1,I) = TMACSB(LENB(I)-3,I)
                  THACSB(1,I) = THACSB(LENB(I)-3,I)
                  TMACSB(2,I) = TMACSB(LENB(I)-2,I)
                  THACSB(2,I) = THACSB(LENB(I)-2,I)
                  TMACSB(3,I) = TMACSB(LENB(I)-1,I)
                  THACSB(3,I) = THACSB(LENB(I)-1,I)
                  TMACSB(4,I) = TIMONA
                  THACSB(4,I) = 0.0
                  TMACSB(5,I) = TUPA
                  THACSB(5,I) = ACSF
                  IPTR = 6
               ELSE
                  CALL spTABLE(TMACSB(1,I),THACSB(1,I),TUPA,THB3,
     .                       LENB(I),INDXB(I))
                  IF (THB3 .GE. (ACSF-EPSL)) THEN

C                    PREVIOUS VALVE STATE WAS HIGH
```

```
                        TMACSB(1,I) = TATAB
                        THACSB(1,I) = ACSF
                        IPTR = 2
                     ELSE

C                       PREVIOUS VALVE STATE WAS DELAY, AND A
C                       CROSS-OVER CONDITION HAS OCCURED

                        TMACSB(1,I) = TMACSB(LENB(I)-3,I)
                        THACSB(1,I) = THACSB(LENB(I)-3,I)
                        TMACSB(2,I) = TMACSB(LENB(I)-2,I)
                        THACSB(2,I) = THACSB(LENB(I)-2,I)
                        TMACSB(3,I) = (TMACSB(LENB(I)-1,I) + TIMONA)
                                      /2.0
                        THACSB(3,I) = (TMACSB(3,I) - TIMONA)*ACSF/TRDNA
                        TMACSB(4,I) = TUPA
                        THACSB(4,I) = ACSF
                        IPTR = 5
                     ENDIF
                  ENDIF
               ENDIF
               TMACSB(IPTR,I) = TIMONA + DTACSB(I)
               THACSB(IPTR,I) = ACSF
               TMACSB(IPTR+1,I) = TMACSB(IPTR,I) + TRDNA
               THACSB(IPTR+1,I) = 0.0
               TMACSB(IPTR+2,I) = 999.0
               THACSB(IPTR+2,I) = 0.0
               LENB(I) = IPTR+2
            ELSE

C              MAKE SURE VALVE IS OFF

               IF (THB1 .LT. EPSL) THEN

C                 PREVIOUS VALVE STATE WAS LOW

                  TMACSB(1,I) = TATAB
                  THACSB(1,I) = 0.0
                  TMACSB(2,I) = 999.0
                  THACSB(2,I) = 0.0
                  LENB(I) = 2
               ELSE
                  CALL spTABLE(TMACSB(1,I),THACSB(1,I),TUPA,THB3,
                               LENB(I),INDXB(I))
                  IF (THB3 .LT. EPSL) THEN

C                    PREVIOUS VALVE STATE WAS EITHER DELAY OR RAMP, WITH
C                    NO CROSSOVER POSSIBLE

                     TMACSB(1,I) = TMACSB(LENB(I)-3,I)
                     THACSB(1,I) = THACSB(LENB(I)-3,I)
                     TMACSB(2,I) = TMACSB(LENB(I)-2,I)
                     THACSB(2,I) = THACSB(LENB(I)-2,I)
                     TMACSB(3,I) = TMACSB(LENB(I)-1,I)
                     THACSB(3,I) = THACSB(LENB(I)-1,I)
                     TMACSB(4,I) = 999.0
                     THACSB(4,I) = 0.0
                     LENB(I) = 4
                  ELSE

C                    PREVIOUS VALVE STATE WAS DELAY, AND CROSSOVER COULD
C                    OCCUR

                     TMACSB(1,I) = TATAB
```

```
                        THACSB(1,I) = ACSF
                        TMACSB(2,I) = TIMONA
                        THACSB(2,I) = ACSF
                        TMACSB(3,I) = TIMONA + TRDNA
                        THACSB(3,I) = 0.0
                        TMACSB(4,I) = 999.0
                        THACSB(4,I) = 0.0
                        LENB(I) = 4
                     ENDIF
                  ENDIF
               ENDIF
  101       CONTINUE

         ENDIF

C        SET REFERENCE TIME FOR TABLE LOOKUPS AND RESET ACS "ON" FLAG

         TREF   = T
         IACSON = 0

C        CALCULATE AVERAGE THRUST LEVELS FOR EACH "A" THRUSTER
C        DURING NEXT CYCLE

         DO 20 I = 1 , 4

C           INITIALIZE TABLE POINTER

            INDXA(I) = 1

C           COMPUTE INSTANTANEOUS THRUST LEVEL VIA TABLE LOOKUP IF ACS "A"
C           CYCLE IS SCHEDULED FOR THIS THRUSTER . ALSO EXTRAPOLATE TIME OF
C           NEXT ACS "A" TABLE LOOKUP INDEX TRANSITION .

            IF ( TMACSA(1,I).GT.0.0e0 ) THEN
               CALL spTABLE(TMACSA(1,I),THACSA(1,I),TREF,ATHRA(I),
     .                      LENA(I),INDXA(I))
               IF ( ATHRA(I) .GE. ACSF-EPSL ) IACSON = 1
            ELSE
               ATHRA(I) = 0.0e0
               INDXA(I) = 0
            ENDIF

C           CALCULATE THE FORCES AND MOMENTS PRODUCED BY THE "A"
C           ACS THRUSTERS :
C                 F(I) IS THE FORCE ALONG THE Ith AXIS.
C                 XMOM(I) IS THE EFFECTIVE MOMENT ARM.
C                 FORCES ARE ADJUSTED FOR MISALIGNMENT EFFECTS.
C                 THE MOMENT GENERATED IS ( F x XMOM ).

            DO 10 J=1,3
               F0(J)   = ACSDIR(J,I)*ATHRA(I)
               XMOM(J) = CG(J) - ACSLOC(J,I)
     10    CONTINUE
            F(1)   = ACSMA(1,I)*F0(1) +ACSMA(4,I)*F0(2) +ACSMA(7,I)*F0(3)
            F(2)   = ACSMA(2,I)*F0(1) +ACSMA(5,I)*F0(2) +ACSMA(8,I)*F0(3)
            F(3)   = ACSMA(3,I)*F0(1) +ACSMA(6,I)*F0(2) +ACSMA(9,I)*F0(3)

            M(1)   = F(2)*XMOM(3) - F(3)*XMOM(2)
            M(2)   = F(3)*XMOM(1) - F(1)*XMOM(3)
            M(3)   = F(1)*XMOM(2) - F(2)*XMOM(1)

            FXACS  = FXACS + F(1)
            FYACS  = FYACS + F(2)
            FZACS  = FZACS + F(3)
```

```
         MXACS  = MXACS + M(1)
         MYACS  = MYACS + M(2)
         MZACS  = MZACS + M(3)
         MDOTA  = MDOTA + ATHRA(I)/ISPACS
   20 CONTINUE

C     CALCULATE AVERAGE THRUST LEVELS FOR EACH "B" THRUSTER
C     DURING NEXT CYCLE

      DO 40 I = 1 , 4

C        INITIALIZE TABLE POINTERS

         INDXB(I) = 1

C        COMPUTE INSTANTANEOUS THRUST LEVEL VIA TABLE LOOKUP IF ACS "B"
C        CYCLE IS SCHEDULED FOR THIS THRUSTER . ALSO EXTRAPOLATE TIME OF
C        NEXT ACS "B" TABLE LOOKUP INDEX TRANSITION .

         IF ( TMACSB(1,I).GT.0.0e0 ) THEN
            CALL spTABLE(TMACSB(1,I),THACSB(1,I),TREF,ATHRB(I),
     .                   LENB(I),INDXB(I))
            IF ( ATHRB(I) .GE. ACSF-EPSL ) IACSON = 1
         ELSE
            ATHRB(I) = 0.0e0
            INDXB(I) = 0
         ENDIF

C        CALCULATE THE FORCES AND MOMENTS PRODUCED BY THE "B"
C        ACS THRUSTERS :
C              F(I) IS THE FORCE ALONG THE Ith AXIS.
C              XMOM(I) IS THE EFFECTIVE MOMENT ARM.
C              FORCES ARE ADJUSTED FOR MISALIGNMENT EFFECTS.
C              THE MOMENT GENERATED IS ( F x XMOM ).

         DO 30 J=1,3
            F0(J)    = -ACSDIR(J,I)*ATHRB(I)
            XMOM(J) = CG(J) - ACSLOC(J,I)
   30    CONTINUE

         F(1)    = ACSMA(1,I)*F0(1) +ACSMA(4,I)*F0(2) +ACSMA(7,I)*F0(3)
         F(2)    = ACSMA(2,I)*F0(1) +ACSMA(5,I)*F0(2) +ACSMA(8,I)*F0(3)
         F(3)    = ACSMA(3,I)*F0(1) +ACSMA(6,I)*F0(2) +ACSMA(9,I)*F0(3)

         M(1)    = F(2)*XMOM(3) - F(3)*XMOM(2)
         M(2)    = F(3)*XMOM(1) - F(1)*XMOM(3)
         M(3)    = F(1)*XMOM(2) - F(2)*XMOM(1)

         FXACS  = FXACS + F(1)
         FYACS  = FYACS + F(2)
         FZACS  = FZACS + F(3)
         MXACS  = MXACS + M(1)
         MYACS  = MYACS + M(2)
         MZACS  = MZACS + M(3)
         MDOTA  = MDOTA + ATHRB(I)/ISPACS
   40 CONTINUE

      RETURN
      END
```

## B.2.6 Uublkdat.for

```
C-----------------------------------------------------------------------
      BLOCKDATA BLKDAT

      IMPLICIT DOUBLE PRECISION         (A-H)
      IMPLICIT DOUBLE PRECISION         (O-Z)

      COMMON / NORCOM / GSET   , ISET

C
C     COMMON "RSPLAG" USED FOR MIDFLIGHT CAPABILITIES ONLY
C
      PARAMETER          (NSAVMX=10)

      DOUBLE PRECISION  TLATCH(NSAVMX)
      DOUBLE PRECISION  LAMMSV(2,NSAVMX)
      DOUBLE PRECISION  RRELSV(3,NSAVMX)
      DOUBLE PRECISION  VRELSV(3,NSAVMX)
      DOUBLE PRECISION  TI2MSV(9,NSAVMX)
      DOUBLE PRECISION  SNRSV(NSAVMX)

      COMMON / RSPLAG / NLATCH , TLATCH , LAMMSV , RRELSV , VRELSV ,
     .                  TI2MSV , SNRSV

      DATA ISET  / 0     /

      DATA NLATCH/0/
      END
```

## B.2.7 Uubrtavg.for

```
C-----------------------------------------------------------------------
      SUBROUTINE BRTAVG(TN,TA,DT,W)
C-----------------------------------------------------------------------
C
C     SUBROUTINE NAME :      BRTAVG
C
C     AUTHOR(S) :            D. F. SMITH
C
C     FUNCTION :             Compute the average body rates over the last
C                            interval using the current and previous
C                            inertial to missile transformation matrices
C
C     CALLED FROM :          GYRO
C
C     SUBROUTINES CALLED :   M3X3I
C
C     INPUTS :               TN,TA,DT
C
C     OUTPUTS :              W
C
C     UPDATES :              D. SMITH    - CR # 076
C
C-----------------------------------------------------------------------

      IMPLICIT DOUBLE PRECISION          (A-H)
      IMPLICIT DOUBLE PRECISION          (O-Z)

      DOUBLE PRECISION  TN(9),           TA(9),          W(3)
      DOUBLE PRECISION  TD(9),           TI(9),          TE(9)

C     COMPUTE INVERSE OF PREVIOUS TRANSFORMATION MATRIX

      CALL M3X3I ( TA , TI )

C     COMPUTE DELTA ROTATION MATRIX FROM PREVIOUS MISSILE ATTITUDE TO
CURRENT
C     MISSILE ATTITUDE

      TD(1)  = TN(1)*TI(1) + TN(4)*TI(2) + TN(7)*TI(3)
      TD(2)  = TN(2)*TI(1) + TN(5)*TI(2) + TN(8)*TI(3)
      TD(3)  = TN(3)*TI(1) + TN(6)*TI(2) + TN(9)*TI(3)
      TD(4)  = TN(1)*TI(4) + TN(4)*TI(5) + TN(7)*TI(6)
      TD(5)  = TN(2)*TI(4) + TN(5)*TI(5) + TN(8)*TI(6)
      TD(6)  = TN(3)*TI(4) + TN(6)*TI(5) + TN(9)*TI(6)
      TD(7)  = TN(1)*TI(7) + TN(4)*TI(8) + TN(7)*TI(9)
      TD(8)  = TN(2)*TI(7) + TN(5)*TI(8) + TN(8)*TI(9)
      TD(9)  = TN(3)*TI(7) + TN(6)*TI(8) + TN(9)*TI(9)

C     DETERMINE DELTA EULER ANGLES FROM PREVIOUS ORIENTATION ( EULER
ROTATION
C     SEQUENCE IS PSI-THETA-PHI )

      DLPSI  = DATAN2 (  TD(4) , TD(1) )
      DLTHE  = DASIN  ( -TD(7) )
      DLPHI  = DATAN2 (  TD(8) , TD(9) )

      CDLPSI = DCOS ( DLPSI )
      SDLPSI = DSIN ( DLPSI )
      CDLTHE = DCOS ( DLTHE )
      SDLTHE = DSIN ( DLTHE )
      CDLPHI = DCOS ( DLPHI )
```

```
      SDLPHI = DSIN ( DLPHI )

C     COMPUTE MATRIX RELATING EULER ANGULAR RATES TO BODY RATES ( [TE]
IS
C     USED FOR TEMPORARY STORAGE )

      TE(1)  =   1.0D0
      TE(2)  =   0.0D0
      TE(3)  =   0.0D0
      TE(4)  =   0.0D0
      TE(5)  =   CDLPSI
      TE(6)  = - SDLPSI
      TE(7)  = - SDLTHE
      TE(8)  =   CDLTHE*SDLPHI
      TE(9)  =   CDLTHE*CDLPHI

C     ADD IDENTITY MATRIX TO [TE] AND INVERT THE RESULTANT MATRIX

      TD(1)  = TE(1) + 1.0D0
      TD(2)  = TE(2)
      TD(3)  = TE(3)
      TD(4)  = TE(4)
      TD(5)  = TE(5) + 1.0D0
      TD(6)  = TE(6)
      TD(7)  = TE(7)
      TD(8)  = TE(8)
      TD(9)  = TE(9) + 1.0D0

      CALL M3X3I ( TD , TI )

C     CALCULATE AVERAGE BODY RATES OVER LAST INTERVAL

      TD(1)  = TI(1)*TE(1) + TI(4)*TE(2) + TI(7)*TE(3)
      TD(2)  = TI(2)*TE(1) + TI(5)*TE(2) + TI(8)*TE(3)
      TD(3)  = TI(3)*TE(1) + TI(6)*TE(2) + TI(9)*TE(3)
      TD(4)  = TI(1)*TE(4) + TI(4)*TE(5) + TI(7)*TE(6)
      TD(5)  = TI(2)*TE(4) + TI(5)*TE(5) + TI(8)*TE(6)
      TD(6)  = TI(3)*TE(4) + TI(6)*TE(5) + TI(9)*TE(6)
      TD(7)  = TI(1)*TE(7) + TI(4)*TE(8) + TI(7)*TE(9)
      TD(8)  = TI(2)*TE(7) + TI(5)*TE(8) + TI(8)*TE(9)
      TD(9)  = TI(3)*TE(7) + TI(6)*TE(8) + TI(9)*TE(9)

      W(1)   = 2.0D0 * ( TD(1)*DLPHI + TD(4)*DLTHE + TD(7)*DLPSI ) / DT
      W(2)   = 2.0D0 * ( TD(2)*DLPHI + TD(5)*DLTHE + TD(8)*DLPSI ) / DT
      W(3)   = 2.0D0 * ( TD(3)*DLPHI + TD(6)*DLTHE + TD(9)*DLPSI ) / DT

      RETURN
      END
```

## B.2.8 Uucorvel.for

```
C-----------------------------------------------------------------------
      SUBROUTINE CORVEL(T,MVR,VTT,RMIR,VMIR,VTTP,VG,VS,MVS,UVS,VC,DLV,
     .                  TFFE,TTFE)
C-----------------------------------------------------------------------
C
C     SUBROUTINE NAME :     CORVEL
C
C     AUTHOR(S) :           M. K. DOUBLEDAY, L. C. HECK
C
C     FUNCTION :            CALCULATES THE CORRELATED VELOCITY
C
C     CALLED FROM :         FORTRAN MAIN
C
C     SUBROUTINES CALLED :  NONE
C
C     INPUTS :              T,MVR,VTT,RMIR,VMIR
C
C     OUTPUTS :             VS,MVS,UVS,VC,DLV,TFFE,TTFE
C
C     BOTH :                VTTP,VG
C
C     UPDATES :             T. THORNTON - CR # 025
C                           D. SMITH    - CR # 013
C                           B. HILL     - CR # 030
C                           T. THORNTON - CR # 033
C                           T. THORNTON - CR # 042
C                           T. THORNTON - CR # 043
C                           T. THORNTON - CR # 044
C                           D. SMITH    - CR # 059
C                           D. SMITH    - CR # 072
C                           B. HILL /   - CR # 081
C                           R. RHYNE
C                           B. HILL     - CR # 093
C
C-----------------------------------------------------------------------

      IMPLICIT REAL         (A-H)
      IMPLICIT REAL         (O-Z)

      REAL  VMIR(3)       ,  RMIR(3)

      REAL  DLV(3)        , MDVT          , MRB
      REAL  MRT           , MTMPV         , MVCE
      REAL  MVR           , MVS           , MVSE
      REAL  RB(3)         , RTPRED(3)
      REAL  TMPV(3)       , URB(3)        , URT(3)
      REAL  UTHP(3)       , UTMPV(3)      , UVS(3)
      REAL  VC(3)         , VCE(3)
      REAL  VD0(3)        , VG(3)         , VGE(3)
      REAL  VPHI(3)       , VS(3)
      REAL  VSE(3)        , VTT(3)        , VTTP(3)

C     LOCAL COMMON USED FOR CONSTANTS AND INITIALIZATION FLAG

      SAVE              ICORV

* DATA INITIALIZATION
$INCLUDE('^/INCLUDE/SSDATA39.DAT')
$INCLUDE('^/INCLUDE/SSDATA42.DAT')
$INCLUDE('^/INCLUDE/SSDATA43.DAT')
$INCLUDE('^/INCLUDE/SSDATA23.DAT')
```

```
      DATA ICORV / 1 /

      IF (ICORV .EQ. 1) THEN

         ICORV = 0

         IF (T .EQ. 0.0) THEN
            ILOOP = 50
         ELSE
            ILOOP = 1
         ENDIF
      ELSE
         ILOOP = 1
      ENDIF

C     ESTIMATE VELOCITY TO BE GAINED (VGE) , CORRELATED VELOCITY (VCE) ,
C     AND STEERING VELOCITY (VSE)

      DO 10 I=1,3
         DLV(I)  = VTT(I) - VTTP(I)
         VGE(I)  = VG(I)  - DLV(I)
         VCE(I)  = VGE(I) + VMIR(I)
         VSE(I)  = VGE(I) - VD0(I)
         VTTP(I) = VTT(I)
   10 CONTINUE

      MVSE   = SQRT ( VSE(1)**2 + VSE(2)**2 + VSE(3)**2 )
      MDVT   = SQRT ( DLV(1)**2 + DLV(2)**2 + DLV(3)**2 )

C     CALCULATE POSITION BIAS SCALE FACTOR

      IF ( MVSE.GT.MVR ) THEN
         SCALE3 = MVR/MVSE
      ELSE
         SCALE3 = 1.0
      END IF

      SCALAR = F2 * MVR * SCALE3 / ( F1 + MDVT )

C     CALCULATE OFFSET POSITION VECTOR

      IF ( T.GE.TSTG2 ) THEN
         RB(1)  = RMIR(1)
         RB(2)  = RMIR(2)
         RB(3)  = RMIR(3)
      ELSE
         RB(1)  = RMIR(1) + SCALAR*VSE(1)
         RB(2)  = RMIR(2) + SCALAR*VSE(2)
         RB(3)  = RMIR(3) + SCALAR*VSE(3)
      END IF

      DO 30 I = 1,ILOOP

C        COMPUTE UNIT VECTORS

         MRB = SQRT(RB(1)**2 + RB(2)**2 + RB(3)**2)
         URB(1) = RB(1)/MRB
         URB(2) = RB(2)/MRB
         URB(3) = RB(3)/MRB

         MRT = SQRT(RTPRED(1)**2 + RTPRED(2)**2 + RTPRED(3)**2)
         URT(1) = RTPRED(1)/MRT
         URT(2) = RTPRED(2)/MRT
```

```
      URT(3) = RTPRED(3)/MRT

      TMPV(1) = URB(2)*URT(3) - URB(3)*URT(2)
      TMPV(2) = URB(3)*URT(1) - URB(1)*URT(3)
      TMPV(3) = URB(1)*URT(2) - URB(2)*URT(1)

      MTMPV = SQRT(TMPV(1)**2 + TMPV(2)**2 + TMPV(3)**2)
      UTMPV(1) = TMPV(1)/MTMPV
      UTMPV(2) = TMPV(2)/MTMPV
      UTMPV(3) = TMPV(3)/MTMPV

      UTHP(1) = UTMPV(2)*URB(3) - UTMPV(3)*URB(2)
      UTHP(2) = UTMPV(3)*URB(1) - UTMPV(1)*URB(3)
      UTHP(3) = UTMPV(1)*URB(2) - UTMPV(2)*URB(1)

C     ESTIMATE HORIZONTAL AND RADIAL COMPONENTS OF VC

      VHC    = VCE(1)*UTHP(1) + VCE(2)*UTHP(2) + VCE(3)*UTHP(3)
      VCR    = VCE(1)*URB(1)  + VCE(2)*URB(2)  + VCE(3)*URB(3)

C     COMPUTE SIN AND COS OF RANGE ANGLE

      VPHI(1) = URB(2)*URT(3) - URB(3)*URT(2)
      VPHI(2) = URB(3)*URT(1) - URB(1)*URT(3)
      VPHI(3) = URB(1)*URT(2) - URB(2)*URT(1)

      SINPHI = SQRT ( VPHI(1)**2 + VPHI(2)**2 + VPHI(3)**2 )
      COSPHI = URB(1)*URT(1) + URB(2)*URT(2) + URB(3)*URT(3)

C     COMPUTE INTERMEDIATE VARIABLES

      MVCE   = SQRT ( VCE(1)**2 + VCE(2)**2 + VCE(3)**2 )

      W      = VHC / MRB
      EL     = MRB * VHC**2 / GMU
      AR     = MRB / MRT
      TP1    = MVCE**2 * MRB / GMU
      HHH    = EL * SINPHI**2 * ( 2.0 - TP1 )
      SQRHHH = SQRT ( HHH )

C     COMPUTE TIME OF FLIGHT ESTIMATE

      T1     = EL * SINPHI / ( HHH * W )
      T2A    = ( 1.0 - EL ) / AR + 1.0 - AR*EL
      T2B    = ( 2.0*EL - 1.0 - 1.0/AR ) * COSPHI
      T2     = T2A + T2B
      T3     = 2.0 * EL**2 * SINPHI**3 / ( W * HHH * SQRHHH )
      T4A    = SQRHHH
      T4B    = EL + AR*EL + COSPHI - 1.0
      T4     = ATAN2( T4A , T4B )
      TFFE   = T1*T2 + T3*T4

C     ESTIMATE TOTAL TIME OF FLIGHT

      TTFE   = T + TFFE

C     COMPUTE TIME OF FREE FALL AND TIME OF FLIGHT ERROR

      TFF    = TTF - T
      DELTF  = TFF - TFFE

C     COMPUTE PARTIAL OF TFF W/RESPECT TO VC

      A      = 2.0 * ( AR - COSPHI ) / SINPHI + ( VCR / VHC )
```

```
            B       = A*VCR - VHC
            C       = B * MRB / GMU
            D       = C * EL * SINPHI**2
            E       = D + HHH/VHC
            PARHV   = E * 2.0

            PART1V = ( 1.0/VHC - PARHV/HHH ) * T1
            PART2V = ( 2.0*EL/VHC ) * ( 2.0*COSPHI - (1.0+AR**2)/AR )
            PART3V = ( 1.0/VHC - PARHV/(2.0*HHH) ) * 3.0 * T3

            SUBEQ1 = ( EL + AR*EL + COSPHI - 1.0 ) * VHC * PARHV
            SUBEQ2 = 4.0 * HHH * EL * ( 1.0 + AR )
            SUBEQ3 = ( EL + AR*EL + COSPHI-1.0 )**2 + HHH
            SUBEQ4 = 2.0 * SQRHHH * VHC

            PART4V = ( SUBEQ1 - SUBEQ2 ) / ( SUBEQ3 * SUBEQ4 )
            PTFFV  = T1*PART2V + T2*PART1V + T3*PART4V + T4*PART3V

            VCOPK  = VHC + DELTF/PTFFV

C           COMPUTE CORRELATED VELOCITY VECTOR

C           HIT EQUATION FOR RADIAL COMPONENT OF VCP

            VCRPK  = VCOPK/(EL*SINPHI) * ( 1.0 - AR*EL - (1.0-EL)*COSPHI )

C           COMPUTE VC,VG,VS

            DO 20 J = 1 , 3
               VC(J) = VCRPK*URB(J) + VCOPK*UTHP(J)
               VG(J) = VC(J) - VMIR(J)
               VS(J) = VG(J) - VD0(J)
   20       CONTINUE

   30    CONTINUE

         MVS = SQRT(VS(1)**2 + VS(2)**2 + VS(3)**2)
         UVS(1) = VS(1)/MVS
         UVS(2) = VS(2)/MVS
         UVS(3) = VS(3)/MVS

         RETURN
         END
```

## B.2.9 Uudnorm.for

```
C-------------  ----------------------------------------------------------
      SUBROUTINE NORM(SD,MN,ISEED,RDN)
C-----------------------------------------------------------------------
C
C     SUBROUTINE NAME :      NORM
C
C     AUTHOR(S) :            D. F. SMITH
C
C     FUNCTION :             GENERATES NORMALLY DISTRIBUTED RANDOM
C                            NUMBERS USING THE BOX-MULLER TRANSFORMATION
C
C     CALLED FROM :          UTILITY SUBROUTINE
C
C     SUBROUTINES CALLED :   RAN0
C
C     INPUTS :               SD,MN
C
C     OUTPUTS :              RDN
C
C     BOTH :                 ISEED
C
C     UPDATES :              D. SMITH     - CR # 062
C                            R. RHYNE     - CR # 087
C
C-----------------------------------------------------------------------

      IMPLICIT DOUBLE PRECISION          (A-H)
      IMPLICIT DOUBLE PRECISION          (O-Z)

      DOUBLE PRECISION  MN
      INTEGER*4 ISEED

      COMMON / NORCOM / GSET    , ISET

      DATA ONE    / 1.0D0 /
      DATA TWO    / 2.0D0 /

C     IF A SPARE RANDOM NUMBER IS NOT AVAILABLE FROM THE PREVIOUS PASS
C     GENERATE TWO NEW ONES

      IF ( ISET.EQ.0 ) THEN

C        GET TWO UNIFORM RANDOM NUMBERS WITHIN THE SQUARE EXTENDING
C        FROM -1 TO 1 IN EACH DIRECTION

    1    V1      = TWO*RAN0(ISEED) - ONE
         V2      = TWO*RAN0(ISEED) - ONE

C        SEE IF THEY ARE WITHIN THE UNIT CIRCLE . IF NOT , TRY AGAIN .

         R       = V1*V1 + V2*V2
         IF ( R.GE.ONE ) GO TO 1

C        PERFORM BOX-MULLER TRANSFORMATION TO GENERATE TWO GAUSSIAN
C        RANDOM NUMBERS . RETURN ONE AND SAVE THE OTHER FOR THE NEXT
C        PASS .

         FAC     = DSQRT ( -TWO*DLOG(R)/R )
         GSET    = FAC*V1
         RDN     = MN + SD*FAC*V2
         ISET    = 1
```

```
C       USE GAUSSIAN RANDOM NUMBER CARRIED OVER FROM PREVIOUS PASS .

        ELSE IF ( ISET.EQ.1 ) THEN
           RDN    = MN + SD*GSET
           ISET   = 0
        ENDIF

        RETURN
        END
```

## B.2.10 Uuestrel.for

```
C-----------------------------------------------------------------------
      SUBROUTINE ESTREL(TI2M,CMS,ESTATE,RREL,
     .                  VREL,MAGR,MAGV,URREL,MGRDOT,TGO,PITER,YAWER,
     .                  LAMD)
C-----------------------------------------------------------------------
C
C     SUBROUTINE NAME :      ESTREL
C
C     AUTHOR(S) :            T. THORNTON
C
C     FUNCTION :             COMPUTES ESTIMATED RELATIVE RANGE, RANGE
C                            RATE, AND TIME-TO-GO
C
C     CALLED FROM :          FORTRAN MAIN
C
C     SUBROUTINES CALLED :   NONE
C
C     INPUTS :               RREL,VREL,TI2M,CMS,ESTATE
C
C     OUTPUTS :              MAGR,MAGV,URREL,MGRDOT,TGO,
C                            PITER,YAWER,LAMD
C
C     UPDATES :              D. SMITH     - CR # 059
C                            R. RHYNE     - CR # 068
C                            D. SISSOM    - CR # 069
C                            B. HILL /    - CR # 081
C                            R. RHYNE
C                            R. RHYNE     - CR # 088
C                            R. RHYNE     - CR # 093
C
C-----------------------------------------------------------------------

      IMPLICIT REAL (A-H)
      IMPLICIT REAL (O-Z)

      REAL  CMS(9)          , LAMD(2)         , LAMSKE(2)
      REAL  MAGR            , MAGV            , MGRDOT
      REAL  RELM(3)         , RELS(3)
      REAL  RREL(3)         , TI2M(9)
      REAL  URREL(3)        , VELM(3)         , VELS(3)
      REAL  VMIR(3)         , VREL(3)         , VTEST(3)
      DOUBLE PRECISION  RTEST(3)
      DOUBLE PRECISION  RMIR(3)
      INTEGER           ESTATE

C     COMPUTE ESTIMATED RELATIVE STATES AND ESTIMATED TIME-TO-GO

      MAGR = SQRT(RREL(1)**2 + RREL(2)**2 + RREL(3)**2)
      URREL(1) = RREL(1)/MAGR
      URREL(2) = RREL(2)/MAGR
      URREL(3) = RREL(3)/MAGR

      MAGV = SQRT(VREL(1)**2 + VREL(2)**2 + VREL(3)**2)

      MGRDOT = VREL(1)*URREL(1) + VREL(2)*URREL(2) + VREL(3)*URREL(3)
      VRDRR  = VREL(1)*RREL(1)  + VREL(2)*RREL(2)  + VREL(3)*RREL(3)
      TGO = -VRDRR/(MAGV**2)

      IF ( ESTATE.EQ.1 ) THEN

C        COMPUTE ESTIMATED RELATIVE STATES MISSILE FRAME
```

```
      RELM(1) = RREL(1)*TI2M(1) + RREL(2)*TI2M(4) + RREL(3)*TI2M(7)
      RELM(2) = RREL(1)*TI2M(2) + RREL(2)*TI2M(5) + RREL(3)*TI2M(8)
      RELM(3) = RREL(1)*TI2M(3) + RREL(2)*TI2M(6) + RREL(3)*TI2M(9)

      VELM(1) = VREL(1)*TI2M(1) + VREL(2)*TI2M(4) + VREL(3)*TI2M(7)
      VELM(2) = VREL(1)*TI2M(2) + VREL(2)*TI2M(5) + VREL(3)*TI2M(8)
      VELM(3) = VREL(1)*TI2M(3) + VREL(2)*TI2M(6) + VREL(3)*TI2M(9)

C     COMPUTE ESTIMATED RELATIVE STATES IN SEEKER FRAME

      RELS(1) = RELM(1)*CMS(1) + RELM(2)*CMS(4) + RELM(3)*CMS(7)
      RELS(2) = RELM(1)*CMS(2) + RELM(2)*CMS(5) + RELM(3)*CMS(8)
      RELS(3) = RELM(1)*CMS(3) + RELM(2)*CMS(6) + RELM(3)*CMS(9)

      VELS(1) = VELM(1)*CMS(1) + VELM(2)*CMS(4) + VELM(3)*CMS(7)
      VELS(2) = VELM(1)*CMS(2) + VELM(2)*CMS(5) + VELM(3)*CMS(8)
      VELS(3) = VELM(1)*CMS(3) + VELM(2)*CMS(6) + VELM(3)*CMS(9)

C     COMPUTE ESTIMATED LINE OF SIGHT ERRORS

      LAMSKE(1) = ATAN2(-RELS(3),RELS(1))
      LAMSKE(2) = ATAN2( RELS(2),RELS(1))

      PITER =   LAMSKE(1)
      YAWER =  -LAMSKE(2)

C     COMPUTE ESTIMATED LINE OF SIGHT RATE ERRORS

      LAMD(1) = (RELS(3)*VELS(1) - RELS(1)*VELS(3)) /
     .            (RELS(1)**2 + RELS(3)**2)
      LAMD(2) = (RELS(1)*VELS(2) - RELS(2)*VELS(1)) /
     .            (RELS(1)**2 + RELS(2)**2)
      ENDIF

      RETURN
      END
```

## B.2.11 Uuestr12.for

```
C-----------------------------------------------------------------------
      SUBROUTINE ESTREL2(RTEST,VTEST,RMIR,VMIR,RREL,VREL)
C-----------------------------------------------------------------------
C
C     SUBROUTINE NAME :      ESTREL2
C
C     AUTHOR(S) :            T. THORNTON
C
C     FUNCTION :             COMPUTES ESTIMATED RELATIVE RANGE, RANGE
C                            RATE, AND TIME-TO-GO
C
C     CALLED FROM :          FORTRAN MAIN
C
C     SUBROUTINES CALLED :   NONE
C
C     INPUTS :               RTEST,VTEST,RMIR,VMIR
C
C     OUTPUTS :              RREL,VREL
C
C     UPDATES :              D. SMITH     - CR # 059
C                            R. RHYNE     - CR # 068
C                            D. SISSOM    - CR # 069
C                            B. HILL /    - CR # 081
C                            R. RHYNE
C                            R. RHYNE     - CR # 088
C                            R. RHYNE     - CR # 093
C
C-----------------------------------------------------------------------

      IMPLICIT DOUBLE PRECISION (A-H)
      IMPLICIT DOUBLE PRECISION (O-Z)

      DOUBLE PRECISION  RREL(3)
      DOUBLE PRECISION  VMIR(3)       , VREL(3)       , VTEST(3)
      DOUBLE PRECISION  RTEST(3)
      DOUBLE PRECISION  RMIR(3)

C     COMPUTE ESTIMATED RELATIVE STATES AND ESTIMATED TIME-TO-GO

      RREL(1) = RTEST(1) - RMIR(1)
      RREL(2) = RTEST(2) - RMIR(2)
      RREL(3) = RTEST(3) - RMIR(3)


      VREL(1) = VTEST(1) - VMIR(1)
      VREL(2) = VTEST(2) - VMIR(2)
      VREL(3) = VTEST(3) - VMIR(3)

      RETURN
      END
```

## B.2.12 Uufv2bxi.for

```
C-----------------------  ------------------------------------------------
      SUBROUTINE FV2BXI ( FV, FVSQ, B )
C-----------------------------------------------------------------------
C
C     SUBROUTINE NAME :      FV2BXI
C
C     AUTHOR(S) :            W. E. EXELY
C
C     FUNCTION :             COMPUTE DIRECTION COSINE MATRIX (B) FROM
C                            THE QUATERNION ATTITUDE VECTOR (FV) AND
C                            COMPUTE THE SQUARE (FVSQ) OF THE MAGNITUDE
C                            OF THE QUATERNION (FV)
C
C     CALLED FROM :          MISSIL
C
C     SUBROUTINES CALLED :   NONE
C
C     INPUTS :               FV
C
C     OUTPUTS :              FVSQ,B
C
C     UPDATES :              D. SMITH     - CR # 59
C
C-----------------------------------------------------------------------
C
      IMPLICIT REAL (A-H)
      IMPLICIT REAL (O-Z)
C
      DIMENSION  FV ( 4 ),   B ( 9 )
C
      DATA   R1,  R2  /   1.0,  2.0  /
C
      F1  = FV(1)
      F2  = FV(2)
      F3  = FV(3)
      F4  = FV(4)
      F1S = F1*F1
      F2S = F2*F2
      F3S = F3*F3
      F4S = F4*F4
      TT  = F1S + F2S + F3S + F4S
C
      IF( TT ) 20, 20, 10
C
   10 CONTINUE
C
      T1   = R2/TT
      T2   = F3*F4
      T3   = F1*F2
      B(2) = T1*( T3 + T2 )
      B(4) = T1*( T3 - T2 )
C
      T2   = F2*F4
      T3   = F1*F3
      B(7) = T1*( T3 + T2 )
      B(3) = T1*( T3 - T2 )
C
      T2   = F1*F4
      T3   = F2*F3
      B(6) = T1*( T3 + T2 )
      B(8) = T1*( T3 - T2 )
```

```
C
      T2    = T1*F4S - R1
      B(1)  = T1*F1S + T2
      B(5)  = T1*F2S + T2
      B(9)  = T1*F3S + T2
C
   20 CONTINUE
C
      FVSQ = TT
C
      RETURN
      END
```

## B.2.13 Uufvdot.for

```
C-----------------------------------------------------------------------
      SUBROUTINE FVDOT ( W, WD, F, FD )
C-----------------------------------------------------------------------
C
C     SUBROUTINE NAME :      FVDOT
C
C     AUTHOR(S) :            W. E. EXELY
C
C     FUNCTION :             COMPUTE THE QUATERNION DERIVATIVES (FD)
C                            USING BODY RATES (W) AND LATENT INTEGRAL
C                            DERIVATIVE (WD) AND THE QUATERNION (F)
C
C     CALLED FROM :          FORTRAN MAIN, MISSIL
C
C     SUBROUTINES CALLED :   NONE
C
C     INPUTS :               W,WD,F
C
C     OUTPUTS :              FD
C
C     UPDATES :              D. SMITH     - CR # 59
C
C-----------------------------------------------------------------------
C
      IMPLICIT REAL (A-H)
      IMPLICIT REAL (O-Z)
C
      DIMENSION W(3), F(4), FD(4)
C
      W1 = W(1)
      W2 = W(2)
      W3 = W(3)
      W4 = WD
      F1 = F(1)
      F2 = F(2)
      F3 = F(3)
      F4 = F(4)
C
      FD(1) = ( W4*F1 + W1*F4 - W2*F3 + W3*F2 ) *0.5
      FD(2) = ( W4*F2 + W1*F3 + W2*F4 - W3*F1 ) *0.5
      FD(3) = ( W4*F3 - W1*F2 + W2*F1 + W3*F4 ) *0.5
      FD(4) = ( W4*F4 - W1*F1 - W2*F2 - W3*F3 ) *0.5
C
      RETURN
      END
```

## B.2.14 Uugyro.for

```
C-------------------------------------------------------------------------
      SUBROUTINE GYRO(T,P,Q,R,CIM,GYSEED,QFRACG,PULSEG)
C-------------------------------------------------------------------------
C
C     SUBROUTINE NAME :      GYRO
C
C     AUTHOR(S) :            A. P. BUKLEY, M. K. DOUBLEDAY
C
C     FUNCTION :             GYRO MODEL COMPUTES SENSED DELTA ANGLE
C                            COUNTS. INCLUDES AXIS MISALIGNMENT AND
C                            NONORTHOGONALITY ERRORS, SCALE FACTOR
C                            ERRORS,RANDOM AND CONSTANT DRIFT, AND
C                            QUANTIZATION.
C
C
C     CALLED FROM :          FORTRAN MAIN
C
C     SUBROUTINES CALLED :   NORM,BRTAVG,RESP2P
C
C     INPUTS :               T,P,Q,R,CIM
C
C     OUTPUTS :              NONE
C
C     BOTH :                 GYSEED,QFRACG,PULSEG
C
C     UPDATES :              T. THORNTON - CR # 004
C                            T. THORNTON - CR # 016
C                            B. HILL     - CR # 020
C                            D  SMITH    - CR # 021
C                            B. HILL     - CR # 022
C                            B. HILL     - CR # 030
C                            B. HILL     - CR # 038
C                            D. SMITH    - CR # 059
C                            D. SISSOM   - CR # 069
C                            D. SMITH    - CR # 070
C                            D. SMITH    - CR # 075
C                            D. SMITH    - CR # 077
C                            D. SMITH    - CR # 078
C                            B. HILL /   - CR # 081
C                            R. RHYNE
C                            R. RHYNE    - CR # 083
C                            R. RHYNE    - CR # 084
C                            R. RHYNE    - CR # 087
C                            B. HILL     - CR # 093
C
C-------------------------------------------------------------------------

      IMPLICIT DOUBLE PRECISION          (A-H)
      IMPLICIT DOUBLE PRECISION          (O-Z)

      DOUBLE PRECISION  CIM(9)         , CIMO(9)        , DCG(3)
      DOUBLE PRECISION  DTHET(3)       , PULSEG(3)      , PQRAVG(3)
      DOUBLE PRECISION  QFRACG(3)      , SF1G(3)        , SF2G(3)
      DOUBLE PRECISION  SFEG(3)        , WBI0(3)
      DOUBLE PRECISION  WBI1(3)        , WBI2(3)        , WBO0(3)
      DOUBLE PRECISION  WBO1(3)        , WBO2(3)        , WDRG(3)

      INTEGER*4           GYSEED

C     LOCAL COMMON USED FOR CONSTANTS, LOCAL VARIABLES AND
C     INITIALIZATION FLAG
```

```
      SAVE              IGYRO

C     COMMON "RGYRO" USED FOR MIDFLIGHT CAPABILITIES ONLY

      COMMON / RGYRO  / PSIG   , THTG   , PHIG   , THXZG  , THXYG  ,
     .                  THYZG  , THYXG  , THZYG  , THZXG  , SF1G   ,
     .                  SF2G   , DCG    , T0GYRO , TIMO   , WBI2   ,
     .                  WBI1   , WBO2   , WBO1   , DRSIGG

* DATA INITIALIZATION
$INCLUDE('^/include/ssdata53.dat')
$INCLUDE('^/include/ssdata16.dat')
$INCLUDE('^/include/ssdata21.dat')

      DATA IGYRO / 1 /

      IF (IGYRO .EQ. 1) THEN

         IGYRO = 0

C        INITIALIZE GYRO PARAMETERS

         IF (T .EQ. 0.0) THEN
            DRSIGG = DRSGGI/(60.0*DSQRT(DTIMU)*DTR)
            CALL NORM(ALNSGG,ALNMNG,GYSEED,PSIG)
            CALL NORM(ALNSGG,ALNMNG,GYSEED,THTG)
            CALL NORM(ALNSGG,ALNMNG,GYSEED,PHIG)
            CALL NORM(AORSGG,AORMNG,GYSEED,THXZG)
            CALL NORM(AORSGG,AORMNG,GYSEED,THXYG)
            CALL NORM(AORSGG,AORMNG,GYSEED,THYZG)
            CALL NORM(AORSGG,AORMNG,GYSEED,THYXG)
            CALL NORM(AORSGG,AORMNG,GYSEED,THZYG)
            CALL NORM(AORSGG,AORMNG,GYSEED,THZXG)
            CALL NORM(SF1SGG,SF1MNG,GYSEED,SF1G(1))
            CALL NORM(SF1SGG,SF1MNG,GYSEED,SF1G(2))
            CALL NORM(SF1SGG,SF1MNG,GYSEED,SF1G(3))
            CALL NORM(SF2SGG,SF2MNG,GYSEED,SF2G(1))
            CALL NORM(SF2SGG,SF2MNG,GYSEED,SF2G(2))
            CALL NORM(SF2SGG,SF2MNG,GYSEED,SF2G(3))
            CALL NORM(DCSIGG,DCMENG,GYSEED,DCG(1))
            CALL NORM(DCSIGG,DCMENG,GYSEED,DCG(2))
            CALL NORM(DCSIGG,DCMENG,GYSEED,DCG(3))
            DO 10 I = 1,3
               WBI2(I) = 0.0D0
               WBI1(I) = 0.0D0
               WBO2(I) = 0.0D0
               WBO1(I) = 0.0D0
   10       CONTINUE
         ENDIF

C     COMPUTE SECOND ORDER RESPONSE DIFFERENCE EQUATION COEFFICIENTS

         IF ( IGRTYP.EQ.2 ) THEN
            CALL RESP2R ( DTIMU,WGYR,ZGYR,CWBI2,CWBI1,CWBI0,CWBO2,CWBO1,
     .                    CWBO0 )
         ENDIF

      ENDIF

C     COMPUTE DELTA TIME SINCE LAST PASS THROUGH GYRO

      DTDEL  = T - T0GYRO
      T0GYRO = T
```

```
C     DETERMINE AVERAGE BODY RATE OVER LAST INTERVAL

      IF ( DTDEL.NE.0.0D0 ) THEN
         CALL BRTAVG ( CIM , CIMO , DTDEL , PQRAVG )
      ELSE
         PQRAVG(1) = P
         PQRAVG(2) = Q
         PQRAVG(3) = R
      ENDIF

C     SAVE INERTIAL-TO-MISSILE ROTATION MATRIX FOR NEXT PASS

      DO 20 I = 1 , 9
         CIMO(I) = CIM(I)
   20 CONTINUE

C     GYRO AXIS MISALIGNMENT EFFECTS

      PM     = PQRAVG(1) + PQRAVG(2)*PSIG - PQRAVG(3)*THTG
      QM     = PQRAVG(2) - PQRAVG(1)*PSIG + PQRAVG(3)*PHIG
      RM     = PQRAVG(3) + PQRAVG(1)*THTG - PQRAVG(2)*PHIG

C     GYRO AXIS NONORTHOGONALITY EFFECTS

      PN     = PM + QM*THXZG - RM*THXYG
      QN     = QM - PM*THYZG + RM*THYXG
      RN     = RM + PM*THZYG - QM*THZXG

C     ADD LINEAR AND QUADRATIC SCALE FACTOR ERRORS

      SFEG(1) = PN + SF1G(1)*PN + SF2G(1)*PN**2
      SFEG(2) = QN + SF1G(2)*QN + SF2G(2)*QN**2
      SFEG(3) = RN + SF1G(3)*RN + SF2G(3)*RN**2

C     FOR EACH AXIS ...

      DO 30 I = 1,3

C        MAKE A GAUSSIAN DRAW FOR RANDOM DRIFT AND ADD TO CONSTANT
C        DRIFT

         IF ( DRSIGG.GT.0.0D0 ) THEN
            CALL NORM(DRSIGG,DRMENG,GYSEED,DRG)
         ENDIF

         WDRG(I) = DRG + DCG(I)

C        COMPUTE INPUT TO GYRO RESPONSE MODEL

         WBI0(I) = SFEG(I) + WDRG(I)

C        SECOND ORDER RESPONSE MODEL

         IF ( IGRTYP.EQ.2 ) THEN
            WBO0(I) = ( CWBI0*WBI0(I) + CWBI1*WBI1(I)
     .                + CWBI2*WBI2(I) - CWBO1*WBO1(I)
     .                - CWBO2*WBO2(I) )/CWBO0
            WBI2(I) = WBI1(I)
            WBI1(I) = WBI0(I)
            WBO2(I) = WBO1(I)
            WBO1(I) = WBO0(I)
         ENDIF
```

```
C         INSTANTANEOUS RESPONSE MODEL

          IF ( IGRTYP.EQ.0 ) THEN
             WBO0(I) = WBI0(I)
          ENDIF

C         COMPUTE DELTA THETA

          DTHET(I) = DTDEL * WBO0(I)

          IF ( SPPG.GT.0.0 ) THEN

C            UNQUANTIZED OUTPUT IN COUNTS

             QFRACG(I) = QFRACG(I) - PULSEG(I) + DTHET(I)/SPPG

C            QUANTIZED OUTPUT IN COUNTS

             PULSEG(I) = DINT(QFRACG(I))
          ELSE
             PULSEG(I) = DTHET(I)
          ENDIF

    30 CONTINUE

       RETURN
       END
```

## B.2.15 Uuimupro.for

```
C-----------------------------------------------------------------------
      SUBROUTINE IMUPRO(T,PULSEG,PULSEA,DELPHI,DELTHT,DELPSI,DELU,
     .                  DELV,DELW)
C-----------------------------------------------------------------------
C
C     SUBROUTINE NAME :      IMUPRO
C
C     AUTHOR(S) :            T. THORNTON
C
C     FUNCTION :             COMPUTES THE IMU PROCESSOR RELATED FUNCTIONS
C
C     CALLED FROM :          FORTRAN MAIN
C
C     SUBROUTINES CALLED :   NONE
C
C     INPUTS :               T,PULSEG,PULSEA
C
C     OUTPUTS :              DELPHI,DELTHT,DELPSI,DELU,DELV,DELW
C
C     UPDATES :              T. THORNTON - CR # 004
C                            T. THORNTON - CR # 016
C                            B. HILL     - CR # 022
C                            T. THORNTON - CR # 037
C                            D. SMITH    - CR # 059
C                            D. SMITH    - CR # 070
C                            D. SMITH    - CR # 075
C                            B. HILL /   - CR # 081
C                            R. RHYNE
C                            B. HILL     - CR # 093
C
C-----------------------------------------------------------------------

      IMPLICIT DOUBLE PRECISION          (A-H)
      IMPLICIT DOUBLE PRECISION          (O-Z)

      DOUBLE PRECISION  PULSEA(3)      , PULSEG(3)

* DATA INITIALIZATION
$INCLUDE('^/INCLUDE/SSDATA54.DAT')

C     GYRO OUTPUT COMPENSATION

C     CALCULATE DELTA ANGLES

      IF ( PERPG.GT.0.0 ) THEN
         DELPHS = PULSEG(1)*PERPG
         DELTHS = PULSEG(2)*PERPG
         DELPSS = PULSEG(3)*PERPG
      ELSE
         DELPHS = PULSEG(1)
         DELTHS = PULSEG(2)
         DELPSS = PULSEG(3)
      END IF

C     COMPENSATE SENSED DELTA ANGLES FOR SCALE FACTOR ERRORS

      DELPH  = DELPHS*SFCGX
      DELTH  = DELTHS*SFCGY
      DELPS  = DELPSS*SFCGZ

C     COMPENSATE SENSED DELTA ANGLES FOR GYRO MISALIGNMENTS
```

```
      DELPHI =  DELPH       - DELTH*PSIGP + DELPS*THTGP
      DELTHT =  DELPH*PSIGP + DELTH       - DELPS*PHIGP
      DELPSI = -DELPH*THTGP + DELTH*PHIGP + DELPS

C     ACCELEROMETER OUTPUT COMPENSATION

C     CALCULATE DELTA VELOCITY

      IF ( PERPA.GT.0.0 ) THEN
         DELUS  = PULSEA(1)*PERPA
         DELVS  = PULSEA(2)*PERPA
         DELWS  = PULSEA(3)*PERPA
      ELSE
         DELUS  = PULSEA(1)
         DELVS  = PULSEA(2)
         DELWS  = PULSEA(3)
      END IF

C     COMPENSATE SENSED VELOCITY FOR SCALE FACTOR ERRORS

      DELXS  = DELUS*SFCAX
      DELYS  = DELVS*SFCAY
      DELZS  = DELWS*SFCAZ

C     COMPENSATE SENSED VELOCITY FOR ACCELEROMETER MISALIGNMENTS

      DELUM  =  DELXS       - DELYS*PSIAP + DELZS*THTAP
      DELVM  =  DELXS*PSIAP + DELYS       - DELZS*PHIAP
      DELWM  = -DELXS*THTAP + DELYS*PHIAP + DELZS

C     SKULLING COMPENSATION

      IF ( ISKULL.EQ.0 ) THEN
         DELU   = DELUM
         DELV   = DELVM
         DELW   = DELWM
      ELSE
         DELU   = DELUM - 0.5 * ( DELPSI*DELVM - DELTHT*DELWM )
         DELV   = DELVM - 0.5 * ( DELPHI*DELWM - DELPSI*DELUM )
         DELW   = DELWM - 0.5 * ( DELTHT*DELUM - DELPHI*DELVM )
      END IF

      RETURN
      END
```

## B.2.16 Uuinteg.for

```
C-----------------------------------------------------------------------
      SUBROUTINE INTEG ( X , XDOT , T , I )
C-----------------------------------------------------------------------
C
C     SUBROUTINE NAME :      INTEG
C
C     AUTHOR(S) :            D. F. SMITH
C
C     FUNCTION :             Perform simple trapezoidal integration of
C                            XDOT to yield X.  DTD is the time since
C                            the last integration and I is the array
C                            index where X is stored
C
C     CALLED FROM :          FORTRAN MAIN
C
C     SUBROUTINES CALLED :   NONE
C
C     INPUTS :               XDOT,T,I
C
C     OUTPUTS :              X
C
C     UPDATES :              D. SISSOM    - CR # 58
C                            D. SMITH     - CR # 59
C
C-----------------------------------------------------------------------
C
      COMMON/STORAG/     XINT,            TINT,            XDOTL
      DOUBLE PRECISION   XINT(50),        TINT(50),        XDOTL(50)
      DOUBLE PRECISION   DT,              DTMP,            X
      DOUBLE PRECISION   XDOT,            T

      DT       = T - TINT(I)

      XINT(I)  = XINT(I) + 0.5D0*DT*(XDOT+XDOTL(I))
      X        = XINT(I)

      TINT(I)  = T
      XDOTL(I) = XDOT

C     TEMPORARY CODE TO NORMALIZE QUATERNION AFTER 4TH COMPONENT IS
REVISED

      IF ( I.EQ.18 ) THEN
         DTMP   = DSQRT ( XINT(15)**2 + XINT(16)**2 + XINT(17)**2 +
     .                    XINT(18)**2 )
         XINT(15) = XINT(15) / DTMP
         XINT(16) = XINT(16) / DTMP
         XINT(17) = XINT(17) / DTMP
         XINT(18) = XINT(18) / DTMP
      END IF

      RETURN
      END
```

## B.2.17 Uuintegi.for

```
C-----------------------------------------------------------------------
      SUBROUTINE INTEGI ( X , XDOT , T , I )
C-----------------------------------------------------------------------
C
C     SUBROUTINE NAME :      INTEGI
C
C     AUTHOR(S) :            D. F. SMITH
C
C     FUNCTION :             Initialize integral of X which is stored
C                            in position I of the integral array
C
C     CALLED FROM :          MAIN
C
C     SUBROUTINES CALLED :   NONE
C
C     INPUTS :               X,XDOT,T,I
C
C     OUTPUTS :              NONE
C
C     UPDATES :              D. SISSOM    - CR # 58
C                            D. SMITH     - CR # 59
C
C-----------------------------------------------------------------------

      COMMON/STORAG/     XINT,            TINT,            XDOTL
      DOUBLE PRECISION   XINT(50),        TINT(50),        XDOTL(50)
      DOUBLE PRECISION   X,               T,               XDOT

      XINT(I)  = X
      XDOTL(I) = XDOT
      TINT(I)  = T

      RETURN
      END
```

## B.2.18 Uukalman.for

```
C-----------------------------------------------------------------------
      SUBROUTINE KALMAN(T,TI2M,LAMMO,ASIG,SNRO,TGO,RRELO,VRELO,TI2MO,
     .                  RACQ,MAGRTR,MAGR,MAGV,LAMSEK,LAMDXX,FRMRAT,CMS,
     .                  MACQ,MCSO,MTERM,IRESLV,TRACK,TERM,TRMTGO,TGE1,
     .                  TGE2AL,WFILT,ZFILT,LAM,LAMD,IBURN1,ACQD,ESTATE,
     .                  PITER,YAWER,ROLLER)
C-----------------------------------------------------------------------
C
C     SUBROUTINE NAME :      KALMAN
C
C     AUTHOR(S) :            D. F. SMITH
C
C     FUNCTION  :            2-STATE EXTENDED KALMAN FILTER
C                            ESTIMATES LOS ANGLES AND RATES
C
C     CALLED FROM  :         FORTRAN MAIN
C
C     SUBROUTINES CALLED :   NONE
C
C     INPUTS :               T,TI2M,LAMMO,ASIG,SNRO,TGO,RRELO,VRELO,
C                            TI2MO,RACQ,MAGRTR,MAGR,MAGV,LAMSEK,LAMDXX,
C                            FRMRAT,CMS,MACQ,MCSO,MTERM,IRESLV
C
C     OUTPUTS :              TRMTGO,TGE1,TGE2AL,WFILT,ZFILT,LAM,
C                            LAMD,IBURN1,ACQD,PITER,YAWER
C
C     BOTH :                 ESTATE,TRACK,TERM
C
C     UPDATES :              D. SISSOM   - CR # 032
C                            B. HILL     - CR # 030
C                            B. HILL     - CR # 038
C                            T. THORNTON - CR # 043
C                            T. THORNTON - CR # 048
C                            D. SMITH    - CR # 059
C                            D. SMITH    - CR # 064
C                            R. RHYNE    - CR # 068
C                            D. SISSOM   - CR # 069
C                            D. SMITH    - CR # 070
C                            D. SMITH    - CR # 074
C                            R. RHYNE    - CR # 079
C                            B. HILL /   - CR # 081
C                            R. RHYNE
C                            B. HILL     - CR # 086
C                            R. RHYNE    - CR # 087
C                            R. RHYNE    - CR # 088
C                            D. SISSOM   - CR # 091
C                            B. HILL     - CR # 093
C
C-----------------------------------------------------------------------

      IMPLICIT REAL          (A-H)
      IMPLICIT REAL          (O-Z)

      CHARACTER*128 MESSAGE
      REAL  CSSHFT(3)      , TMSHFT(3)      , TKSHFT(3)
      REAL  LAMSEK(2)      , LAMDXX(2)      , MAGRSQ
      REAL  LAM(2)         , LAMD(2)        , MAGRO
      REAL  RRELO(3)       , VRELO(3)       , RATE(6)
      REAL  LAMMO(2)       , TI2MO(9)       , TI2M(9)
      REAL  MAGR           , MAGV           , MAGRTR
      REAL  CMS(9)
```

```
      INTEGER           SEKTYP        , ACQD
      INTEGER           ESTATE        , TRACK         , TERM

C     LOCAL COMMON USED FOR CONSTANTS, LOCAL VARIABLES AND
C     INITIALIZATION FLAG

      SAVE              IKALMN

C     COMMON "RKALMN" USED FOR MIDFLIGHT CAPABILITIES ONLY

      COMMON / RKALMN / TKF     , IDRTOK , PP11    , PP12    , PP22    ,
     .                  PY11    , PY12   , PY22    , PLMDFP  , YLMDFP  ,
     .                  PLAMH   , YLAMH  , PLAMDH  , YLAMDH  , PLAMDF  ,
     .                  YLAMDF  , TGIL   , KFMODE  , IFPAS

* DATA INITIALIZATION
$INCLUDE('^/INCLUDE/SSDATA48.DAT')
$INCLUDE('^/INCLUDE/SSDATA50.DAT')
$INCLUDE('^/INCLUDE/SSDATA55.DAT')
$INCLUDE('^/INCLUDE/SSDATA56.DAT')
$INCLUDE('^/INCLUDE/SSDATA57.DAT')
$INCLUDE('^/INCLUDE/SSDATA11.DAT')
$INCLUDE('^/INCLUDE/SSDATA12.DAT')

      DATA IKALMN / 1 /

      IF (IKALMN .EQ. 1) THEN

         IKALMN = 0

         IF (IFPAS .EQ. 0) THEN

C           INITIALIZE FILTER PARAMETERS

            KFMODE = 1
            TKF    = T

C           INITIALIZE FILTER ESTIMATES OF INERTIAL FRAME LAMBDA AND
C           LAMBDA DOT

            PLMDH1 = (RRELO(3)*VRELO(1) - RRELO(1)*VRELO(3))/
     .               (RRELO(1)**2 + RRELO(3)**2)
            PLAMDH = PLMDH1
            YLMDH1 = (RRELO(1)*VRELO(2) - RRELO(2)*VRELO(1))/
     .               (RRELO(1)**2 + RRELO(2)**2)
            YLAMDH = YLMDH1

C           INITIALIZE COVARIANCE MATRIX ELEMENTS

            PP22   = SGP22**2
            PY22   = SGP22**2
            PP12   = SGP12**2
            PY12   = SGP12**2
            PP11   = SGP11**2
            PY11   = SGP11**2

C           INITIALIZE PROCESS NOISE COVARIANCE

            RW     = SGW**2

C           INITIALIZE MEASUREMENT NOISE MATRIX

            RV     = AKSGME*ASIG**2
```

```
         ENDIF

      ENDIF

C     INCREMENT FILTER PASS COUNTER

      IFPAS  = IFPAS + 1

C     PERFORM EXECUTIVE FUNCTION FOR SEEKER TYPES 0 AND 1

      IF ( SEKTYP.EQ.0 .OR. SEKTYP.EQ.1 ) THEN

C        INITIATE ACQUISTION MODE

         IF ( ACQD.EQ.0 .AND. MAGRTR.LE.RACQ ) THEN
            ESTATE = 0
            ACQD   = 1
            TRMTGO = TGO - (MAGR - RNGTRM)/MAGV
            TGIL   = TRMTGO + TBWAIT
            TGE2AL = TGIL + DTVCS2
            CALL OUTMES(' INITIATE ACQUISITION PHASE')
         ENDIF

C     COMPUTE THE SEEKER DATA RATE

         IF ( TRACK .EQ. 1 ) THEN
            TRACK  = 2
            TGE1   = TGO - (RNHITS + ILAG)/FRMRAT
            IBURN1 = 0
            CALL OUTMES(' INITIATE TRACK PHASE')
         ELSEIF ( TERM .EQ. 1 ) THEN
            TERM   = 2
            CALL OUTMES(' INITIATE TERMINAL PHASE')
         ENDIF

      ENDIF

C     USE TRUE LOS ANGLES AND RATES WITH PERFECT SEEKER MODEL

      IF ( SEKTYP.EQ.0 .AND. ESTATE.EQ.0) THEN
         LAMD(1) = LAMDXX(1)
         LAMD(2) = LAMDXX(2)
         PITER =   LAMMO(1)
         YAWER =   LAMMO(2)
         ROLLER = 0.0
         RETURN
      ENDIF

C     DETERMINE APPARENT RELATIVE INERTIAL FRAME STATES FOR LOCAL USE

      RXI    =   RRELO(1)
      RYI    =   RRELO(2)
      RZI    =   RRELO(3)

      VXI    =   VRELO(1)
      VYI    =   VRELO(2)
      VZI    =   VRELO(3)

      MAGRO  =   SQRT ( RXI**2 + RYI**2 + RZI**2 )

C     RECONSTRUCT MEASURED LOS VECTOR IN SEEKER FRAME

      TANPCH =   TAN ( LAMMO(1) )
```

```
      TANYAW =   TAN ( LAMMO(2) )

      XLOSS  =   1.0E0 / SQRT ( 1.0D0 + TANPCH**2 + TANYAW**2 )
      YLOSS  =   XLOSS * TANYAW
      ZLOSS  = - XLOSS * TANPCH

C     ROTATE MEASURED LOS VECTOR INTO MISSILE FRAME

      XLOSM  = CMS(1)*XLOSS + CMS(2)*YLOSS + CMS(3)*ZLOSS
      YLOSM  = CMS(4)*XLOSS + CMS(5)*YLOSS + CMS(6)*ZLOSS
      ZLOSM  = CMS(7)*XLOSS + CMS(8)*YLOSS + CMS(9)*ZLOSS

C     ROTATE MEASURED LOS VECTOR INTO INERTIAL FRAME

      XLOSI  = TI2MO(1)*XLOSM + TI2MO(2)*YLOSM + TI2MO(3)*ZLOSM
      YLOSI  = TI2MO(4)*XLOSM + TI2MO(5)*YLOSM + TI2MO(6)*ZLOSM
      ZLOSI  = TI2MO(7)*XLOSM + TI2MO(8)*YLOSM + TI2MO(9)*ZLOSM

C     DETERMINE MEASURED LOS ANGLES IN INERTIAL FRAME

      PLAMM  = ATAN2 ( -ZLOSI , XLOSI )
      YLAMM  = ATAN2 (  YLOSI , XLOSI )

C     EXECUTE FILTER INITIALIZATION LOGIC ON FIRST FILTER PASS


C     THE FOLLOWING INITIALIZATION IS DONE HERE, RATHER THAN IN THE
C     INITIAL SECTION TO AVOID REPETITIVE CALCULATIONS TO OBTAIN THE
C     VALUES OF PLAMM AND YLAMM

      IF ( IFPAS.EQ.1 ) THEN

         PLAMH1 = PLAMM
         PLAMH  = PLAMH1
         YLAMH1 = YLAMM
         YLAMH  = YLAMH1

      ENDIF

C     DETERMINE TIME SINCE LAST FILTER UPDATE

      IF ( T.GT.TKF ) THEN
         DTKF   = T - TKF
      ELSE
         DTKF   = 0.0E0
      ENDIF
      TKF    = T

C     ENABLE FIRST BURN WHEN DATA RATE IS SUFFICIENT (SEEKER TYPE 2)
C     OR WHEN IN TERMINAL MODE (SEEKER TYPE 3)

      IF ( (SEKTYP.EQ.2.AND.FRMRAT.GE.RATE(5).AND.IDRTOK.EQ.0) .OR.
     .   (SEKTYP.EQ.3 .AND. IDRTOK.EQ.0 .AND. MTERM.EQ.1) ) THEN
         TGE1   = TGO - RNHITS/FRMRAT
         IBURN1 = 0
         IDRTOK = 1
      ENDIF

C     ENABLE ACQUISITION MODE ON FIRST PASS

      IF ( (SEKTYP.NE.3 .AND. KFMODE.EQ.1 .AND. SNRO.GE.SNRACQ) .OR.
     .   (SEKTYP.EQ.3 .AND. KFMODE.EQ.1 .AND. MACQ.EQ.1) ) THEN
         WRITE(MESSAGE,101) T,MAGRO
         CALL OUTMES(MESSAGE)
```

```
  101    FORMAT(1X,E16.9,' ACQUISITION MODE ENABLED:  MAGRO = ',E16.9)
         KFMODE = 2
         ACQD   = 1
       ELSEIF ((SEKTYP.NE.3 .AND. KFMODE.EQ.2 .AND. SNRO.GE.SNRTRK) .OR.
      .   (SEKTYP.EQ.3 .AND. KFMODE.EQ.2 .AND. MACQ.EQ.1) ) THEN

C        REINITIALIZE ERROR COVARIANCE DIAGONAL ELEMENTS SWITCH FROM
C        ACQUISITION TO TRACK MODE

         WRITE(MESSAGE,102) T,MAGRO
         CALL OUTMES(MESSAGE)
  102    FORMAT(1X,E16.9,' TRACK MODE ENABLED:  MAGRO = ',E16.9)
         KFMODE = 3
         MAGRSQ = MAGRO**2
         TGOSQ  = TGO**2
         PP11   = PP11 + TKSHFT(3)**2/MAGRSQ
         PY11   = PY11 + TKSHFT(2)**2/MAGRSQ
         PP22   = PP22 + TKSHFT(3)**2/(MAGRSQ*TGOSQ)
         PY22   = PY22 + TKSHFT(2)**2/(MAGRSQ*TGOSQ)
       ENDIF

       IF ( KFMODE.GE.3 .AND. IFPAS.GE.NINT(RNHITS) ) ESTATE = 0

C      REINITIALIZE ERROR COVARIANCE DIAGONAL ELEMENTS AT SWITCH FROM
C      TRACK TO DISCRIMINATION MODE

       IF ( (SEKTYP.NE.3 .AND. KFMODE.EQ.3 .AND. SNRO.GE.SNRCSO) .OR.
      .   (SEKTYP.EQ.3 .AND. KFMODE.EQ.3 .AND. MCSO.EQ.1) ) THEN
         WRITE(MESSAGE,103) T,MAGRO
         CALL OUTMES(MESSAGE)
  103    FORMAT(1X,E16.9,' CSO MODE ENABLED:  MAGRO = ',E16.9)
         KFMODE = 4
         MAGRSQ = MAGRO**2
         TGOSQ  = TGO**2
         PP11   = PP11 + CSSHFT(3)**2/MAGRSQ
         PY11   = PY11 + CSSHFT(2)**2/MAGRSQ
         PP22   = PP22 + CSSHFT(3)**2/(MAGRSQ*TGOSQ)
         PY22   = PY22 + CSSHFT(2)**2/(MAGRSQ*TGOSQ)
       ENDIF

C      REINITIALIZE ERROR COVARIANCE DIAGONAL ELEMENTS AT SWITCH FROM
C      DISCRIMINATION TO TERMINAL MODE (SEEKER TYPE 2) OR FRAME RATE
C      EQUALS 12.5 (SEEKER TYPE 3) AND ENABLE SECOND BURN

       IF ( (SEKTYP.NE.3 .AND. KFMODE.EQ.4 .AND. SNRO.GE.SNRTRM) .OR.
      .   (SEKTYP.EQ.3 .AND. KFMODE.EQ.4 .AND. FRMRAT.GE.RATE(3)) ) THEN
         WRITE(MESSAGE,104) T,MAGRO
         CALL OUTMES(MESSAGE)
  104    FORMAT(1X,E16.9,' TERMINAL MODE ENABLED:  MAGRO = ',E16.9)
         KFMODE = 5
         TGE2AL = TGO - RNHITS/FRMRAT
         TRMTGO = TGO - RNHITS/FRMRAT
         MAGRSQ = MAGRO**2
         TGOSQ  = TGO**2
         PP11   = PP11 + TMSHFT(3)**2/MAGRSQ
         PY11   = PY11 + TMSHFT(2)**2/MAGRSQ
         PP22   = PP22 + TMSHFT(3)**2/(MAGRSQ*TGOSQ)
         PY22   = PY22 + TMSHFT(2)**2/(MAGRSQ*TGOSQ)
       ENDIF

C      COMPUTE R ( MEASUREMENT NOISE MATRIX ) FOR CURRENT TIME

       RV     = AKSGME * ASIG**2
```

```
C     PROCESS NOISE TERMS AS A FUNCTION OF HOMING PHASE

      IF (  KFMODE.GT.2 .AND. KFMODE.LT.5  ) THEN
         RW      = SGWH**2
      ELSE IF ( KFMODE.EQ.5 ) THEN
         RW      = SGWT**2
      ENDIF

C     COMPUTE Q ( PROCESS NOISE MATRIX ) FOR CURRENT TIME

      Q11     = RW * DTKF**2 / 4.0E0
      Q12     = RW * DTKF / 2.0E0
      Q22     = RW

C     EXTRAPOLATE COVARIANCE MATRIX TO CURRENT TIME
C     P(N+1) = PHI(N)*P(N)*PHI(N)T + Q

      PPX     = PP12 + DTKF*PP22
      PYX     = PY12 + DTKF*PY22
      PP11    = Q11 + PP11 + DTKF*(PP12+PPX)
      PY11    = Q11 + PY11 + DTKF*(PY12+PYX)
      PP12    = Q12 + PPX
      PY12    = Q12 + PYX
      PP22    = Q22 + PP22
      PY22    = Q22 + PY22

C     COMPUTE KALMAN FILTER GAIN MATRIX :
C
C     K(N)    = P(N-)*HT*( H*P(N-)*HT + RV )**-1

      DNP     = PP11 + RV
      DNY     = PY11 + RV
      AKP11   = PP11 / DNP
      AKY11   = PY11 / DNY
      AKP21   = PP12 / DNP
      AKY21   = PY12 / DNY

      IF ( AKP11.GT.GFLIM  ) AKP11 = GFLIM
      IF ( AKY11.GT.GFLIM  ) AKY11 = GFLIM
      IF ( AKP21.GT.GFDLIM ) AKP21 = GFDLIM
      IF ( AKY21.GT.GFDLIM ) AKY21 = GFDLIM

C     COMPUTE FILTER BANDWIDTH AND DAMPING

      IF ( AKP21.GT.0.0E0 .AND  DTKF.GT.0.0E0 ) THEN
         WFILT  = SQRT ( AKP21 / DTKF )
         ZFILT  = AKP11 * WFILT / ( 2.0E0 * AKP21 )
      ENDIF

C     UPDATE COVARIANCE MATRIX :
C       +
C     P(N)  = ( I - K(N)*H ) * P(N)-

      PP22    = PP22 - AKP21*PP12
      PY22    = PY22 - AKY21*PY12
      PP12    = PP12 - AKP21*PP11
      PY12    = PY12 - AKY21*PY11
      PP11    = PP11 - AKP11*PP11
      PY11    = PY11 - AKY11*PY11

C     ESTIMATE DELTA LOS ANGULAR RATE DUE TO MISSILE MOTION ( 'PLANT'
C     INPUT OR FORCING FUNCTION )

      PLMDF   = ( RZI*VXI - RXI*VZI ) / ( RXI**2 + RZI**2 )
```

```
      YLMDF  = ( RXI*VYI - RYI*VXI ) / ( RXI**2 + RYI**2 )

      IF ( DTKF.NE.0.0E0 ) THEN
         DLPLMD = ( PLMDF - PLMDFP )
         DLYLMD = ( YLMDF - YLMDFP )
      ELSE
         DLPLMD = 0.0E0
         DLYLMD = 0.0E0
      ENDIF

      PLMDFP = PLMDF
      YLMDFP = YLMDF

C     EXTRAPOLATE FILTERED INERTIAL FRAME STATES TO CURRENT TIME

      PLAMH1 = PLAMH + DTKF * ( PLAMDH + 0.5E0*DTKF*DLPLMD )
      YLAMH1 = YLAMH + DTKF * ( YLAMDH + 0.5E0*DTKF*DLYLMD )

      PLMDH1 = PLAMDH + DLPLMD
      YLMDH1 = YLAMDH + DLYLMD

C     REVISE FILTER ESTIMATES OF INERTIAL FRAME LAMBDA AND LAMBDA DOT :
C     ^   +  ^
C     X(N) = X(N)¯+ K(N)*( Y(N) - H*X(N)¯)

      ERRP   = PLAMM - PLAMH1
      ERRY   = YLAMM - YLAMH1
      PLAMH  = PLAMH1 + AKP11*ERRP
      PLAMDH = PLMDH1 + AKP21*ERRP
      YLAMH  = YLAMH1 + AKY11*ERRY
      YLAMDH = YLMDH1 + AKY21*ERRY

C     EXTRAPOLATE LOS ANGLES AHEAD TO ACCOUNT FOR SIGNAL PROCESSING LAG

      IF ( DTKF.NE.0.0E0 ) THEN
         DLPLMD = DLPLMD * SPLAG / DTKF
         DLYLMD = DLYLMD * SPLAG / DTKF
      ELSE
         DLPLMD = 0.0E0
         DLYLMD = 0.0E0
      ENDIF

      PLAMF  = PLAMH + SPLAG * ( PLAMDH + 0.5E0*SPLAG*DLPLMD )
      YLAMF  = YLAMH + SPLAG * ( YLAMDH + 0.5E0*SPLAG*DLYLMD )

      PLAMDF = PLAMDH + DLPLMD
      YLAMDF = YLAMDH + DLYLMD

C     RECONSTRUCT FILTERED LOS VECTOR IN INERTIAL FRAME

      TANPCH =   TAN ( PLAMF )
      TANYAW =   TAN ( YLAMF )
      COSPSQ =   COS ( PLAMF ) **2
      COSYSQ =   COS ( YLAMF ) **2

      XLOSI  =   1.0E0 / SQRT ( 1.0E0 + TANPCH**2 + TANYAW**2 )
      YLOSI  =   XLOSI * TANYAW
      ZLOSI  = - XLOSI * TANPCH

C     DETERMINE FILTERED LOS VECTOR RATES IN INERTIAL FRAME

      XLOSDI = - ( PLAMDF*TANPCH/COSPSQ
     .           + YLAMDF*TANYAW/COSYSQ ) * XLOSI**3
      YLOSDI =     YLAMDF*XLOSI /COSYSQ + XLOSDI*TANYAW
```

```
      ZLOSDI =   - PLAMDF*XLOSI /COSPSQ - XLOSDI*TANPCH

C     ROTATE LOS VECTOR INTO MISSILE FRAME

      XLOSM  = TI2M(1)*XLOSI + TI2M(4)*YLOSI + TI2M(7)*ZLOSI
      YLOSM  = TI2M(2)*XLOSI + TI2M(5)*YLOSI + TI2M(8)*ZLOSI
      ZLOSM  = TI2M(3)*XLOSI + TI2M(6)*YLOSI + TI2M(9)*ZLOSI

C     ROTATE LOS VECTOR RATES INTO MISSILE FRAME

      XLOSDM = TI2M(1)*XLOSDI + TI2M(4)*YLOSDI + TI2M(7)*ZLOSDI
      YLOSDM = TI2M(2)*XLOSDI + TI2M(5)*YLOSDI + TI2M(8)*ZLOSDI
      ZLOSDM = TI2M(3)*XLOSDI + TI2M(6)*YLOSDI + TI2M(9)*ZLOSDI

C     ROTATE LOS VECTOR INTO SEEKER FRAME

      XLOSS  = CMS(1)*XLOSM + CMS(4)*YLOSM + CMS(7)*ZLOSM
      YLOSS  = CMS(2)*XLOSM + CMS(5)*YLOSM + CMS(8)*ZLOSM
      ZLOSS  = CMS(3)*XLOSM + CMS(6)*YLOSM + CMS(9)*ZLOSM

C     ROTATE LOS VECTOR RATES INTO SEEKER FRAME

      XLOSDS = CMS(1)*XLOSDM + CMS(4)*YLOSDM + CMS(7)*ZLOSDM
      YLOSDS = CMS(2)*XLOSDM + CMS(5)*YLOSDM + CMS(8)*ZLOSDM
      ZLOSDS = CMS(3)*XLOSDM + CMS(6)*YLOSDM + CMS(9)*ZLOSDM

C     DETERMINE LOS ANGLES IN SEEKER FRAME

      LAM(1) = ATAN2 ( -ZLOSS , XLOSS )
      LAM(2) = ATAN2 (  YLOSS , XLOSS )

C     DETERMINE LOS ANGULAR RATES IN SEEKER FRAME

      TANPCH  = TAN ( LAM(1) )
      TANYAW  = TAN ( LAM(2) )
      COSPSQ  = COS ( LAM(1) ) **2
      COSYSQ  = COS ( LAM(2) ) **2

      LAMD(1) = ( - ZLOSDS - XLOSDS*TANPCH ) * COSPSQ / XLOSS
      LAMD(2) = (   YLOSDS - XLOSDS*TANYAW ) * COSYSQ / XLOSS

C     DETERMINE ATTITUDE ERRORS

      IF ( ESTATE .EQ. 0 ) THEN
         PITER  =  LAM(1)
         YAWER  = -LAM(2)
         ROLLER =  0.0
      ENDIF

      RETURN
      END
```

## B.2.19 Uum3x3i.for

```
C-----------------------------------------------------------------------
------ --
      SUBROUTINE M3X3I ( A , B )
C-----------------------------------------------------------------------
--------
C
C     SUBROUTINE NAME :      M3X3I
C
C     AUTHOR(S) :            D. F. SMITH
C
C     FUNCTION :             Compute the inverse of a 3 by 3 matrix .
C
C     CALLED FROM :          UTILITY ROUTINE
C
C     SUBROUTINES CALLED :   NONE
C
C     INPUTS :               A
C
C     OUTPUTS :              B
C
C     UPDATES :              NONE
C
C-----------------------------------------------------------------------
--------

      IMPLICIT DOUBLE PRECISION          (A-H)
      IMPLICIT DOUBLE PRECISION          (O-Z)

      DOUBLE PRECISION  A(3,3),          B(3,3)

      DET    = A(1 1)*A(2,2)*A(3,3) - A(1,1)*A(2,3)*A(3,2)
     .       + A(1,2)*A(2,3)*A(3,1) - A(1,2)*A(2,1)*A(3,3)
     .       + A(1,3)*A(2,1)*A(3,2) - A(1,3)*A(2,2)*A(3,1)

      IF ( DET.NE.0.0D0 ) THEN
         B(1,1) = ( A(2,2)*A(3,3) - A(2,3)*A(3,2) ) / DET
         B(2,1) = ( A(2,3)*A(3,1) - A(2,1)*A(3,3) ) / DET
         B(3,1) = ( A(2,1)*A(3,2) - A(2,2)*A(3,1) ) / DET
         B(1,2) = ( A(1,3)*A(3,2) - A(1,2)*A(3,3) ) / DET
         B(2,2) = ( A(1,1)*A(3,3) - A(1,3)*A(3,1) ) / DET
         B(3,2) = ( A(1,2)*A(3,1) - A(1,1)*A(3,2) ) / DET
         B(1,3) = ( A(1,2)*A(2,3) - A(1,3)*A(2,2) ) / DET
         B(2,3) = ( A(1,3)*A(2,1) - A(1,1)*A(2,3) ) / DET
         B(3,3) = ( A(1,1)*A(2,2) - A(1,2)*A(2,1) ) / DET
      ELSE
         B(1,1) = 0.0D0
         B(2,1) = 0.0D0
         B(3,1) = 0.0D0
         B(1,2) = 0.0D0
         B(2,2) = 0.0D0
         B(3,2) = 0.0D0
         B(1,3) = 0.0D0
         B(2,3) = 0.0D0
         B(3,3) = 0.0D0
      END IF

      RETURN
      END
```

## B.2.20 Uumasspr.for

```
C-----------------------------------------------------------------------
      SUBROUTINE MASSPR(T,MDOTA,MDOTV,MASS,EISP,IMASS,
     .                  MDOT,WEIGHT,WDOTTP,WDOTKV,WDOTTI,IXX,
     .                  IYY,IZZ)
C-----------------------------------------------------------------------
C
C     SUBROUTINE NAME :      MASSPR
C
C     AUTHOR(S) :            B. HILL
C
C     FUNCTION :             CALCULATE MISSILE MASS PROPERTIES
C
C     CALLED FROM :          MAIN
C
C     SUBROUTINES CALLED :   TABLE
C
C     INPUTS :               T,MDOTT,MDOTF,MDOTA,MDOTV,MASS,EISP
C
C     OUTPUTS :              MDOT,WEIGHT,WDOTTP,WDOTFR,WDOTKV,WDOTTI,CG,
C                            IXX,IYY,IZZ
C
C     BOTH :                 TBRK,IMASS
C
C     UPDATES :              D. SMITH     - CR # 059
C                            D. SISSOM    - CR # 069
C                            D. SMITH     - CR # 076
C                            D. SMITH     - CR # 080
C                            B. HILL /    - CR # 081
C                            R. RHYNE
C                            R. RHYNE     - CR # 087
C                            B. HILL      - CR # 089
C                            B. HILL      - CR # 093
C
C-----------------------------------------------------------------------

      IMPLICIT REAL          (A-H)
      IMPLICIT REAL          (O-Z)

      REAL  INERXX(20)     , INERYY(20)
      REAL  INERZZ(20)     , IXX           , IYY
      REAL  IZZ            , MASS          , MASSL
      REAL  MASST1(20)     , MASST2(20)    , MDOT
      REAL  MDOTA          , MDOTV

C     LOCAL COMMON USED TO HOLD CONSTANTS AND INITIALIZATION FLAG

      SAVE               IDATIN , BISP

C     COMMON "RMASS" USED FOR MIDFLIGHT CAPABILITIES ONLY

      COMMON / RMASS   / TLSTM  , MASSL

* DATA INITIALIZATION
$INCLUDE('^/INCLUDE/SSDATA45.DAT')
$INCLUDE('^/INCLUDE/SSDATA58.DAT')
$INCLUDE('^/INCLUDE/SSDATA22.DAT')
$INCLUDE('^/INCLUDE/SSDATA23.DAT')

      DATA IDATIN / 1 /
      DATA ICG / 1 /, III / 1 /
```

```
      IF (IMASS .EQ. 1) THEN

         IMASS = 0

         IF (IDATIN .EQ. 1) THEN

            IDATIN = 0

C           ZERO BOOSTER SPECIFIC IMPULSE AFTER SECOND STAGE

            BISP = 0.0
            EISP = 0.0
         ENDIF

      ENDIF

C     CALCULATE TOTAL MASS FLOW RATE

      MDOT   = - MDOTA - MDOTV

C     CONVERT MASS TO WEIGHT

      WEIGHT = MASS*XMTOF

C     CALCULATE WEIGHT EXPULSION RATES

      WDOTTP = 0.0
      WDOTTI = 0.0

      WDOTKV = (- MDOTA - MDOTV)*XMTOF

C     CALCULATE MISSILE MOMENT OF INERTIA

      CALL spTABLE(MASST2,INERXX,MASS,IXX,20,III)
      CALL spTABLE(MASST2,INERYY,MASS,IYY,20,III)
      CALL spTABLE(MASST2,INERZZ,MASS,IZZ,20,III)

      RETURN
      END
```

## B.2.21 Uumcauto.for

```
C-----------------------------------------------------------------------
      SUBROUTINE MCAUTO(T,IXX,IYY,IZZ,SP,SQ,SR,ROLLER,PITER,YAWER,IDIST,
     .                  IACSON,IBURND,IBURNM,IDMEAS,IPASSM,ICMD,TRATON,
     .                  TPATON,TYATON,DTSAMP,TSAL,TSAH,TLAPS,ITHRES,
     .                  ANVP,ACSLEV,TMAUTO,initflag)
C-----------------------------------------------------------------------
C
C     SUBROUTINE NAME :      MCAUTO
C
C     AUTHOR     :           R. RHYNE
C
C     FUNCTION   :           GENERATES ACS COMMANDS TO NULL LARGE
C                            ATTITUDE ERRORS AND RATES DURING MIDCOURSE
C
C     CALLED FROM  :         FORTRAN MAIN
C
C     SUBROUTINES CALLED :   NONE
C
C     INPUTS :               T,IXX,IYY,IZZ,SP,SQ,SR,ROLLER,PITER,
C                            YAWER,IDIST,IACSON,IBURND,IBURNM,IDMEAS
C
C     OUTPUTS :              ICMD,TRATON,TPATON,TYATON,DTSAMP,TSAL,TSAH,
C                            TLAPS,ITHRES,ANVP,ACSLEV,TMAUTO
C
C     BOTH :                 IPASSM
C
C     UPDATES :              B. HILL /    - CR # 081
C                            R. RHYNE
C                            D. SMITH     - CR # 082
C                            R. RHYNE     - CR # 083
C                            R. RHYNE     - CR # 087
C                            R. RHYNE     - CR # 090
C                            D. SMITH     - CR # 092
C                            B. HILL      - CR # 093
C
C-----------------------------------------------------------------------

      IMPLICIT REAL          (A-H)
      IMPLICIT REAL          (O-Z)

      REAL  I1(3)          , ANGACL(3,4,10), OMEGAI(3)
      REAL  OMEGA(3)       , TBURNA(3)     , MOMARM(3)
      REAL  AERROR(3)      , OMEGAD        , AACCEL(3,4)
      REAL  IXX            , IYY           , IZZ
      INTEGER            IMCPAS(3,4), initflag

C     COMMON "RMAUTO" USED FOR MIDFLIGHT CAPABILITIES ONLY

      COMMON / RMAUTO / ANGACL , IMCPAS , TP2END , TP3END , IP2END ,
     .                  TCOAST , ICOAST , TRDONE , IRATE  , IACSB1 ,
     .                  IACSB2 , ICNT   , IVPFL  , IVPFLN , TBURN2 ,
     .                  OMEGAI , TLSTMA , AACCEL

* DATA INITIALIZATION
$INCLUDE('^/INCLUDE/SSDATA59.DAT')
$INCLUDE('^/INCLUDE/SSDATA60.DAT')
$INCLUDE('^/INCLUDE/SSDATA01.DAT')
$INCLUDE('^/INCLUDE/SSDATA02.DAT')
$INCLUDE('^/INCLUDE/SSDATA05.DAT')
$INCLUDE('^/INCLUDE/SSDATA07.DAT')
$INCLUDE('^/INCLUDE/SSDATA08.DAT')
```

```
$INCLUDE('^/INCLUDE/SSDATA19.DAT')

      IF ( IPASSM.EQ.0 ) THEN

C        INITIALIZE ACCELERATION TABLE, PULSE FLAGS, AND PULSE TIMES

         MOMARM(1) = RIARM
         MOMARM(2) = PIARM
         MOMARM(3) = YIARM
         II(1)     = IXX
         II(2)     = IYY
         II(3)     = IZZ
         DO 10 I = 1,3
            ANGACL(I,1,1) = 2.*ACSFL*MOMARM(I)/II(I)
            ANGACL(I,2,1) = 2.*ACSFH*MOMARM(I)/II(I)
            IF ( I.EQ.1 ) THEN
               ANGACL(I,3,1) = 4.*ACSFL*MOMARM(I)/II(I)
               ANGACL(I,4,1) = 4.*ACSFH*MOMARM(I)/II(I)
            ELSE
               ANGACL(I,3,1) = 0.
               ANGACL(I,4,1) = 0.
            ENDIF
            DO 4 J = 1,4
               IMCPAS(I,J) = 1
               AACCEL(I,J) = ANGACL(I,J,1)
               DO 3 K = 2,10
                  ANGACL(I,J,K) = 0.
 3             CONTINUE
 4          CONTINUE
10       CONTINUE
         IPASSM = 1
         ICNT   = 0
         IP2END = 1
         ICOAST = 1
         TP2END = 1000.0
         TP3END = 1000.0
         TCOAST = 1000.0
         TRDONE = 1000.0
      ENDIF

      if (initflag .ne. 0 ) then

C     TIME SINCE LAST CALL

      DTMCA  = T - TLSTMA
      TLSTMA = T

C     DETERMINE IF CORRECTION REQUIRED AND ISSUE APPROPRIATE COMMAND

      IF ( ICMD.EQ.0  .AND.  IDIST.EQ.0
     .        .AND.  IBURNM.NE.0  .AND. IBURND.EQ.0 ) THEN

         IF ( ABS(ROLLER).GE.CAPHL ) THEN

C           COMPUTE INITIAL ROLL CORRECTION BURN TIME

            ICMD   = 1
            IVPFL  = 3
            IACSB1 = 1
            IF ( ABS(ROLLER).GE.4.*CAPHL ) IVPFL = 2
            OMEGAD = ROLLER*AACCEL(1,IVPFL)/ABS(ROLLER)
            IF ( SP/ROLLER.LT.0. ) THEN
               RLLER0 = ROLLER + SP**2/(2.*OMEGAD)
            ELSE
```

```
            RLLER0 = ROLLER
         ENDIF
         TBACS = SQRT(ABS(RLLER0)/(2.*AACCEL(1,IVPFL))) - SP/OMEGAD

      ELSEIF ( ABS(SP).GT.CRPHL ) THEN

C        DEFINE ROLL RATE CORRECTION COMMAND

         ICMD   = 1
         IRATE  = 1
         IACSB1 = 1
         IF ( ABS(SP).GT.750.*CRPH ) THEN
            IVPFL = 4
         ELSEIF ( ABS(SP).GT.375.*CRPH ) THEN
            IVPFL = 2
         ELSEIF ( ABS(SP).GT.15.*CRPH ) THEN
            IVPFL = 3
         ELSE
            IVPFL = 1
         ENDIF

      ELSEIF ( IDMEAS.NE.2 ) THEN

         IF ( ABS(PITER).GT.CATHL ) THEN

C           COMPUTE INITIAL PITCH CORRECTION BURN TIME

            OMEGAD = PITER*AACCEL(2,2)/ABS(PITER)
            IF ( SQ/PITER.LT.0. ) THEN
               PITER0 = PITER + SQ**2/(2.*OMEGAD)
            ELSE
               PITER0 = PITER
            ENDIF
            TBACS = SQRT(ABS(PITER0)/(2.*AACCEL(2,2))) - SQ/OMEGAD

C           ISSUE PITCH COMMAND

            ICMD   = 2
            IVPFL  = 2
            IACSB1 = 1

         ELSEIF ( ABS(YAWER).GT.CAPSL ) THEN

            OMEGAD = YAWER*AACCEL(3,2)/ABS(YAWER)
            IF ( SR/YAWER.LT.0. ) THEN
               YAWER0 = YAWER + SR**2/(2.*OMEGAD)
            ELSE
               YAWER0 = YAWER
            ENDIF
            TBACS = SQRT(ABS(YAWER0)/(2.*AACCEL(3,2))) - SR/OMEGAD

C           ISSUE YAW COMMAND

            ICMD   = 3
            IVPFL  = 2
            IACSB1 = 1

         ELSEIF ( TSAH.GT.T+TSMPH+EPSL .AND. IDMEAS.EQ.1 ) THEN

C           ENABLE KV AUTOPILOT

            TSAL   = T
            TSAH   = T
            TLAPS  = T
```

```
            ENDIF

         ELSEIF ( IBURND.EQ.0 ) THEN

C           NULL BODY RATES BEFORE DISTURBANCE PULSE ISSUED

            IF ( ABS(SQ).GE.CRTH ) THEN
               ICMD   = 2
               IVPFL  = 1
               IF ( ABS(SQ).GT.35.*CRTH ) IVPFL = 2
               IRATE  = 1
               IACSB1 = 1
            ELSEIF ( ABS(SR).GE.CRPS ) THEN
               ICMD   = 3
               IVPFL  = 1
               IF ( ABS(SR).GT.35.*CRPS ) IVPFL = 2
               IRATE  = 1
               IACSB1 = 1
            ENDIF

         ENDIF
      ENDIF

C     EXECUTE CONTROL LOGIC IF ATTITUDE/RATE CORRECTION REQUIRED

      IF ( ICMD.NE.0 ) THEN

C        ZERO ACS BURN VECTOR AND FORM ANGULAR RATE AND ERROR VECTORS

         TBURNA(1) = 0.
         TBURNA(2) = 0.
         TBURNA(3) = 0.

         OMEGA(1) = SP
         OMEGA(2) = SQ
         OMEGA(3) = SR

         AERROR(1) = ROLLER
         AERROR(2) = PITER
         AERROR(3) = YAWER

C        UPDATE ANGULAR ACCELERATION TABLE

         IF ( IACSON.EQ.1 ) THEN
            ICNT   = ICNT + 1
            IF ( ICNT.EQ.1 ) OMEGAI(ICMD) = OMEGA(ICMD)
            IF ( ICNT.GE.2 ) THEN
               DO 12 I = IMCPAS(ICMD,IVPFL),1,-1
                  IF (I.LT.10) ANGACL(ICMD,IVPFL,I+1) =
                                                ANGACL(ICMD,IVPFL,I)
12             CONTINUE
               ANGACL(ICMD,IVPFL,1)=ABS(OMEGAI(ICMD)-OMEGA(ICMD))/DTMCA
               OMEGAI(ICMD) = OMEGA(ICMD)
               IMCPAS(ICMD,IVPFL) = IMCPAS(ICMD,IVPFL) + 1
               IF (IMCPAS(ICMD,IVPFL).GE.ISAMP) IMCPAS(ICMD,IVPFL)=ISAMP
            ENDIF
         ELSE
            ICNT   = 0
         ENDIF

C        COMPUTE EXPECTED ANGULAR ACCELERATION

         AACCEL(ICMD,IVPFL) = 0.0
         DO 20 I = 1,IMCPAS(ICMD,IVPFL)
```

```
            AACCEL(ICMD,IVPFL) = AACCEL(ICMD,IVPFL)+ANGACL(ICMD,IVPFL,I)
20          CONTINUE
            AACCEL(ICMD,IVPFL) = AACCEL(ICMD,IVPFL)/
     .                                          (IMCPAS(ICMD,IVPFL))

C           EXECUTE BURN LOGIC

            IF ( IRATE.EQ.1 ) THEN

C              RATE CORRECTION

               IF ( IACSB1.EQ.1 ) THEN
                  TBURNA(ICMD) = -OMEGA(ICMD)/AACCEL(ICMD,IVPFL)
                  DTSAMP = ABS(TBURNA(ICMD))
                  TRDONE = T + DTSAMP + TLAGA + TRDNA
                  ITHRES = 1
                  IACSB1 = 0
                  ICNT   = 0
                  TSAL   = 1000.
                  TSAH   = 1000.
                  TLAPS  = 1000.
               ELSEIF ( T.GE.TRDONE ) THEN
                  TRDONE = 1000.
                  IRATE  = 0
                  ICMD   = 0
               ENDIF

            ELSEIF ( IACSB1.EQ.1 ) THEN

C              ENABLE FIRST ATTITUDE CONTROL PULSE

               TBURNA(ICMD) = AERROR(ICMD)*TBACS/ABS(AERROR(ICMD))
               DTSAMP = ABS(TBURNA(ICMD))
               ITHRES = 1
               TCOAST = T + DTSAMP + TLAGA + TRDNA
               ICOAST = 0
               IACSB1 = 0
               ICNT   = 0
               TSAL   = 1000.
               TSAH   = 1000.
               TLAPS  = 1000.

            ELSEIF ( T.GE.TCOAST .AND. ICOAST.EQ.0 ) THEN

C              COMPUTE SECOND BURN TO LEAVE DESIRED LOW LEVEL BURN

               ICOAST = 1
               IACSB2 = 1
               IF ( OMEGA(ICMD).LT.0. ) THEN
                  DIRECT = -1.
               ELSE
                  DIRECT = 1.
               ENDIF
               IF ( ICMD.EQ.1  .AND.  IVPFL.EQ.2 ) THEN
                  IVPFLN = 3
               ELSE
                  IVPFLN = 1
               ENDIF
               TBURN2=(OMEGA(ICMD)-DIRECT*AACCEL(ICMD,IVPFLN)*TBURN3)
     .                                             /AACCEL(ICMD,IVPFL)

            ELSEIF ( T.GE.TCOAST .AND. IACSB2.EQ.1 ) THEN

C              ENABLE ACS BURN WHEN ATTITUDE ERROR EQUALS EXPECTED
```

```
C           DISTANCE FROM DESIRED LOW LEVEL THIRD PULSE ERROR

            THET2D = OMEGA(ICMD) - AACCEL(ICMD,IVPFL)*TBURN2
            THT2DD = -DIRECT*AACCEL(ICMD,IVPFLN)
            THT1DD = -DIRECT*AACCEL(ICMD,IVPFL)
            DELANG = 0.5*(THET2D**2 - OMEGA(ICMD)**2)/THT1DD +
           .              2.*THET2D*TBURN3 - 0.5*THET2D**2/THT2DD
            DELNXT = AERROR(ICMD) - OMEGA(ICMD)*DTMCU
            IF ( ABS(DELANG).GE.ABS(DELNXT) ) THEN
               IACSB2 = 0
               ICNT   = 0
               TBURNA(ICMD) = -TBURN2
               DTSAMP = ABS(TBURNA(ICMD))
               ITHRES = 1
               IP2END = 1
               TP2END = T + DTSAMP + TLAGA + TRDNA
               DELANG = 0.
            ENDIF

         ELSEIF ( T.GE.TP2END .AND. IP2END.EQ.1 ) THEN

C           DEFINE LOW LEVEL ACS PULSE FOR 'FINE TUNING'

            DELANG = 0.5*OMEGA(ICMD)**2/AACCEL(ICMD,IVPFLN)
            DELNXT = AERROR(ICMD) - OMEGA(ICMD)*DTMCU
            TDELAN = (ABS(AERROR(ICMD)) - DELANG)/ABS(OMEGA(ICMD))
            IF ( DELANG.GE.ABS(DELNXT) .OR. TDELAN.GT.2.5*TBURN3 .OR.
           .     OMEGA(ICMD)/AERROR(ICMD).LT.0. ) THEN
               IP2END = 0
               ICNT   = 0
               TBURNA(ICMD) = -OMEGA(ICMD)/AACCEL(ICMD,IVPFLN)
               DTSAMP = ABS(TBURNA(ICMD))
               ITHRES = 1
               IVPFL  = IVPFLN
               TP3END = T + DTSAMP + TLAGA + TRDNA
            ENDIF

         ELSEIF ( T.GE.TP3END ) THEN

C           CORRECTION COMPLETE FOR Ith AXIS

            TP3END = 1000.
            DELANG = 0.
            ICMD   = 0

         ENDIF
      ENDIF

C     DEFINE ACS LEVEL AND VALVE PAIR CONFIGURATION BASED ON
C     ACCELERATION TABLE INDEX USED

      IF ( IVPFL.EQ.4 ) THEN
         ACSLEV = 2.
         ANVP   = 2.
      ELSEIF ( IVPFL.EQ.3 ) THEN
         ACSLEV = 1.
         ANVP   = 2.
      ELSEIF ( IVPFL.EQ.2 ) THEN
         ACSLEV = 2.
         ANVP   = 1.
      ELSE
         ACSLEV = 1.
         ANVP   = 1.
      ENDIF
```

```
C       UPDATE ACS BURN COMMANDS

        TRATON = TBURNA(1)
        TPATON = TBURNA(2)
        TYATON = TBURNA(3)

C       CALCULATE NEXT TIME TO CALL

        TMAUTO = T + DTMCU - EPSL
        endif

        RETURN
        END
```

## B.2.22 Uumcguid.for

```
C-----------------------------------------------------------------------
      SUBROUTINE MCGUID(T,TI2M,VG,URREL,MASS,IDIST,MIDBRN,MAGR,MAGV,SP,
     .                  SQ,SR,PITER,YAWER,FLIP,IVCS,ICMD,IDMEAS,IDPASS,
     .                  IDROP,IMCEND,IBURND,IBURNM,VGM,ADISTT,ROLLER,
     .                  TMGUID)
C----- -----------------------------------------------------------------
C
C     SUBROUTINE NAME :     MCGUID
C
C     AUTHOR    :           R. RHYNE
C
C     FUNCTION  :           DEFINES ROLL ERROR, SEQUENCES MIDCOURSE
C                           EVENTS, AND ENABLES MIDCOURSE DIVERTS
C
C     CALLED FROM  :        FORTRAN MAIN
C
C     SUBROUTINES CALLED :  NONE
C
C     INPUTS :              T,TI2M,VG,URREL,MASS,IDIST,MIDBRN,MAGR,
C                           MAGV,SP,SQ,SR,PITER,YAWER,FLIP,ICMD
C
C     OUTPUTS :             IDMEAS,IDPASS,IMCEND,IBURND,IBURNM,VGM,
C                           ADISTT,ROLLER,TMGUID
C
C     BOTH :                IDROP
C
C     UPDATES :             B. HILL /   - CR # 081
C                           R. RHYNE
C                           R. RHYNE    - CR # 083
C                           R. RHYNE    - CR # 084
C                           R. RHYNE    - CR # 087
C                           R. RHYNE    - CR # 090
C                           B. HILL     - CR # 093
C
C-----------------------------------------------------------------------

      IMPLICIT REAL (A-H)
      IMPLICIT REAL (O-Z)

      CHARACTER*128 MESSAGE
      REAL TI2M(9)     , VG(3)        , URREL(3)
      REAL MASS        , MAGR         , MAGV
      REAL VGM(3)      , ADISTT(4,3)  , OMEGA0(3)
      REAL VGP(3)      , VGPM(3)      , ACQRNG(4,4)
      REAL RATE(6)     , TRGSIG(4)
      INTEGER           ISEQ(4)     , FLIP         , SEKTYP
      INTEGER           BCKGRD

C     LOCAL COMMON USED FOR CONSTANTS AND INITIALIZATION FLAG

      SAVE              IMGUID

C     COMMON "RMGUID" USED FOR MIDFLIGHT CAPABILITIES ONLY

      COMMON / RMGUID / ISEQ    , TVCOMP , OMEGA0 , IMIDB2 , TMIDB2 ,
     .                  ISK3ON

* DATA INITIALIZATION
$INCLUDE('^/INCLUDE/SSDATA46.DAT')
$INCLUDE('^/INCLUDE/SSDATA48.DAT')
$INCLUDE('^/INCLUDE/SSDATA50.DAT')
```

```
$INCLUDE('^/INCLUDE/SSDATA55.DAT')
$INCLUDE('^/INCLUDE/SSDATA60.DAT')
$INCLUDE('^/INCLUDE/SSDATA61.DAT')
$INCLUDE('^/INCLUDE/SSDATA62.DAT')
$INCLUDE('^/INCLUDE/SSDATA01.DAT')
$INCLUDE('^/INCLUDE/SSDATA04.DAT')
$INCLUDE('^/INCLUDE/SSDATA05.DAT')
$INCLUDE('^/INCLUDE/SSDATA09.DAT')
$INCLUDE('^/INCLUDE/SSDATA12.DAT')
$INCLUDE('^/INCLUDE/SSDATA13.DAT')
$INCLUDE('^/INCLUDE/SSDATA17.DAT')

      DATA IMGUID / 1 /

      IF ( IMGUID .EQ. 1 ) THEN
         IMGUID = 0
         IF ( SEKTYP.EQ.2 ) THEN
            TSIG   = TRGSIG(ITRGSG)
            TSGACQ = TSIG
            RAQREF = ACQRNG(BCKGRD,ITRGSG)
            RNGAQ  = SQRT((TSGACQ/TSIG)*(6.0/SNRACQ)*
                                    (SQRT(1./RATE(1))))*RAQREF
         ELSE IF ( SEKTYP.EQ.3 ) THEN
            RNGAQ  = ACQR3
         ELSE
            RNGAQ  = RNGACQ
         ENDIF
      ENDIF

C     GET VG IN BODY FRAME

      VGM(1) = TI2M(1)*VG(1) + TI2M(4)*VG(2) + TI2M(7)*VG(3)
      VGM(2) = TI2M(2)*VG(1) + TI2M(5)*VG(2) + TI2M(8)*VG(3)
      VGM(3) = TI2M(3)*VG(1) + TI2M(6)*VG(2) + TI2M(9)*VG(3)

C     CALCULATE ROLL ERROR IF KV REORIENTATION AND UPLINK HAVE OCCURRED

      IF ( FLIP.EQ.0 .AND. T.GE.TUPLK1 .AND. IMCEND.EQ.0 ) THEN

         VGDLOS = URREL(1)*VG(1) + URREL(2)*VG(2) + URREL(3)*VG(3)

C        DETERMINE PERPENDICULAR COMPONENT OF VG

         VGP(1) = VG(1) - VGDLOS*URREL(1)
         VGP(2) = VG(2) - VGDLOS*URREL(2)
         VGP(3) = VG(3) - VGDLOS*URREL(3)

C        GET VGP IN BODY FRAME

         VGPM(1) = TI2M(1)*VGP(1) + TI2M(4)*VGP(2) + TI2M(7)*VGP(3)
         VGPM(2) = TI2M(2)*VGP(1) + TI2M(5)*VGP(2) + TI2M(8)*VGP(3)
         VGPM(3) = TI2M(3)*VGP(1) + TI2M(6)*VGP(2) + TI2M(9)*VGP(3)

         IF ( VGPM(3).NE.0.0 ) THEN
            RERR = -ATAN2(VGPM(2),VGPM(3))
         ELSE
            PIO2 = PI/2.
            RERR = -SIGN(PIO2,X)
         ENDIF

C        ESTIMATE REQUIRED DIVERT DURATION

         ACM    = FLATM/MASS
         TBURNY = ABS(VGPM(2)/ACM)
```

```
            TBURNZ = ABS(VGPM(3)/ACM)
            TBURN  = AMAX1(TBURNY,TBURNZ)

C           BYPASS MAJOR ROLL CORRECTION IF BURN TIME ALONG EITHER
C           AXIS IS BELOW VCS BURN THRESHOLD

            IF ( TBURN.LT.TCMINV .AND. ICMD.EQ.0 ) THEN
               ROLLER = 0.
               IVCS   = 0
            ELSE IF ( ABS(TBURNY).LT.TCMINV .AND. ICMD.EQ.0 ) THEN
               ROLLER = 0.
               IF ( VGPM(3) .GT. 0. ) THEN
                  IVCS = 4
               ELSE
                  IVCS = 2
               ENDIF
            ELSE IF ( ABS(TBURNZ).LT.TCMINV .AND. ICMD.EQ.0 ) THEN
               ROLLER = 0.
               IF ( VGPM(2) .GT. 0. ) THEN
                  IVCS = 3
               ELSE
                  IVCS = 1
               ENDIF

C           DEFINE ROLL ERROR TO ALIGN VGPM WITH NEAREST VCS THRUSTER

            ELSE IF ( ICMD .EQ. 0 ) THEN
               IF ( ABS(RERR) .LE. PI/4. ) THEN
                  ROLLER = RERR
                  IVCS   = 4
               ELSE IF ( RERR .LE. -3.*PI/4. ) THEN
                  ROLLER = PI + RERR
                  IVCS   = 2
               ELSE IF ( RERR .GE.  3.*PI/4. ) THEN
                  ROLLER = RERR - PI
                  IVCS   = 2
               ELSE IF ( RERR.LT.3.*PI/4. .AND. RERR.GT.PI/4. ) THEN
                  ROLLER = RERR - PI/2.
                  IVCS   = 1
               ELSE
                  ROLLER = RERR + PI/2.
                  IVCS   = 3
               ENDIF

C           IF ATTITUDE CORRECTION IN PROGRESS, USE SAME
C           ROLL ERROR CALCULATION

            ELSE
               IF ( IVCS .EQ. 1 ) THEN
                  ROLLER = RERR - PI/2.
               ELSE IF ( IVCS .EQ. 2 ) THEN
                  IF ( RERR .LT. 0. ) THEN
                     ROLLER = PI + RERR
                  ELSE
                     ROLLER = RERR - PI
                  ENDIF
               ELSE IF ( IVCS .EQ. 3 ) THEN
                  ROLLER = RERR + PI/2.
               ELSE
                  ROLLER = RERR
               ENDIF
            ENDIF

         ELSE
```

```
C        ZERO ROLL ERROR IF PITCHOVER AND FIRST UPLINK HAVE NOT OCCURRED

         ROLLER = 0.

      ENDIF

      IF ( IDMEAS.EQ.0 .AND. ICMD.EQ.0 .AND. ABS(PITER).LE.CATHL
     .      .AND. ABS(YAWER).LE.CAPSL .AND. (IGIT.EQ.0 .OR.
     .                        (IGIT.EQ.1 .AND. T.GE.TDROP)) ) THEN

C        ENTER DISTURBANCE MEASUREMENT MODE

         WRITE(MESSAGE,10) T
         CALL OUTMES(MESSAGE)
10       FORMAT(1X,E16.9,' KV PITCHOVER COMPLETE - BEGIN',
     .                              ' DISTURBANCE MEASUREMENT')
         IDMEAS = 2
      ENDIF

      IF ( IDMEAS.EQ.2 .AND. ABS(SP).LE.CRPHL .AND. ABS(SQ).LE.CRTH
     .      .AND. ABS(SR).LE.CRPS .AND. ICMD.EQ.0 ) THEN

         IF ( IDPASS .EQ. 0 ) THEN

C           DEFINE VCS DISTURBANCE SEQUENCE

            IF ( ABS(VGM(2)) .GE. ABS(VGM(3)) ) THEN
               INDEXY = 1
               INDEXZ = 3
            ELSE
               INDEXY = 3
               INDEXZ = 1
            ENDIF
            IF ( VGM(2) .GE. 0. ) THEN
               ISEQ(INDEXY) = 3
               ISEQ(INDEXY+1) = 1
            ELSE
               ISEQ(INDEXY) = 1
               ISEQ(INDEXY+1) = 3
            ENDIF
            IF ( VGM(3) .GE. 0. ) THEN
               ISEQ(INDEXZ) = 4
               ISEQ(INDEXZ+1) = 2
            ELSE
               ISEQ(INDEXZ) = 2
               ISEQ(INDEXZ+1) = 4
            ENDIF
            IDPASS = 1
         ENDIF

         IF ( IBURND .EQ. 0 ) THEN

C          DROP BOOST ADAPTER AND NOSE FAIRING PRIOR TO FIRST
C          DISTURBANCE BURN - IF EVENT DRIVEN LOGIC, SCHEDULE
C          SEPARATION HERE - OTHERWISE, SEPARATION WILL OCCUR
C          AT T=TDROP IN MAIN ROUTINE

            IF ( IDROP.EQ.0 .AND. IGIT.EQ.0 ) THEN
               IDROP  = 1
            ELSE

C              DEFINE Ith DISTURBANCE BURN
```

```
               IBURND = 1
               IBURNM = 0
               TVCOMP = T + TLAGV + TBURND + TRDNV + TIWAIT
               IVCS   = ISEQ(IDPASS)
               OMEGA0(1) = SP
               OMEGA0(2) = SQ
               OMEGA0(3) = SR
            ENDIF

         ELSE IF ( T .GT. TVCOMP ) THEN

C           COMPUTE ANGULAR ACCEL INDUCED BY PREVIOUS DISTURBANCE BURN

            IBURND = 0
            ADISTT(ISEQ(IDPASS),1) = (SP - OMEGA0(1))/TBURND
            ADISTT(ISEQ(IDPASS),2) = (SQ - OMEGA0(2))/TBURND
            ADISTT(ISEQ(IDPASS),3) = (SR - OMEGA0(3))/TBURND
            IDPASS = IDPASS + 1
            TVCOMP   = 1000.
            IF ( IDPASS .GT. 4 ) THEN
               IDMEAS = 1
               WRITE(MESSAGE,15) T
               CALL OUTMES(MESSAGE)
15             FORMAT(1X,E16.9,' DISTURBANCE MEASUREMENT COMPLETE -',
     .                        ' ORIENT KV TO LOS')
            ENDIF
         ENDIF
      ENDIF

C     ENABLE SEEKER AFTER PITCHOVER AND DISTURBANCE
C     MEASUREMENT COMPLETED

      IF ( ABS(PITER).LE.CATH .AND. ABS(YAWER).LE.CAPS
     .   .AND. ABS(SQ).LE.CRTH .AND. ABS(SR).LE.CRPS
     .   .AND. FLIP.EQ.1 .AND. IDMEAS.EQ.1 ) THEN

C        ENABLE SEEKER (TYPES 0,1,&2) IF EVENT DRIVEN LOGIC -
C        OTHERWISE WILL BE ENABLED BY MAIN ROUTINE AT SECOND
C        STAGE SEPARATION - SEEKER TYPE 3 HANDLED BELOW -
C        TYPE 3 ENABLED BY MAIN ROUTINE AT T=TSK3ON IF EVENT
C        LOGIC NOT USED

         FLIP  = 0
         WRITE(MESSAGE,20) T
         CALL OUTMES(MESSAGE)
20       FORMAT(1X,E16.9,' KV ORIENTATION COMPLETE')
      ENDIF

      IF ( SEKTYP.EQ.3 .AND. IGIT.EQ.0 .AND. MAGR.LE.ACQR3
     .                                  .AND. ISK3ON.EQ.0 ) THEN
         ISK3ON = 1
         WRITE(MESSAGE,30) T
         CALL OUTMES(MESSAGE)
30       FORMAT(1X,E16.9,' SEEKER 3 ENABLED')
      ENDIF

C     DEFINE THREE MIDCOURSE DIVERTS

      IF ( ABS(ROLLER).LE.CAPH .AND. ABS(SP).LE.CRPH
     .     .AND. ICMD.EQ.0 .AND. T.GT.TUPLK1 ) THEN
         DELMID = ( MAGR - RNGAQ )/MAGV
         IF ( ICMD.EQ.0 .AND. MIDBRN.EQ.0 ) THEN
            IBURNM = 0
            IMIDB2 = 1
```

```
            ELSE IF ( IDIST.EQ.0 .AND. MIDBRN.EQ.1 .AND. IMIDB2.EQ.1 ) THEN
               TMIDB2 = T + 0.5*DELMID
               IMIDB2 = 0
            ELSE IF ( T.GE.TMIDB2 .AND. MIDBRN.EQ.1 ) THEN
               IBURNM = 0
            ELSE IF ( IDIST.EQ.0 .AND. MIDBRN.EQ.2 ) THEN
               TMAX   = TBURN + TBWAIT
               IF ( DELMID .LE. TMAX+DTMCU ) THEN
                  IBURNM = 0
                  ROLLER = 0.
                  IMCEND = 1
               ENDIF
            ENDIF

         ENDIF

C        COMPUTE TIME OF NEXT CALL

         TMGUID = T + DTMCU - EPSL

         RETURN
         END
```

## B.2.23 Uumissil.for

```
C-----------------------------------------------------------------------
      SUBROUTINE MISSIL(T,CIM,MASS,
     .                  FXACS,FXVCS,FYACS,FYVCS,
     .                  FZACS,FZVCS,
     .                  X,Y,Z,NCLEAR,UD,VD,WD,
     .                  GB,GR,MGR,FX,FY,FZ,XDD,YDD,ZDD,MXYZDD)
C-----------------------------------------------------------------------
C
C     SUBROUTINE NAME :       MISSIL
C
C     AUTHOR(S) :             D. C. FOREMAN, A. P. BUKLEY
C
C     FUNCTION :              COMPUTES THE ROTATIONAL AND TRANSLATIONAL
C                             MISSILE ACCELERATIONS
C
C     CALLED FROM :           FORTRAN MAIN
C
C     SUBROUTINES CALLED :    FVDOT,FV2BXI
C
C     INPUTS :                T,QUAT,CIM,P,Q,R,IXX,IYY,IZZ,MASS,FXA,
C                             FXT,FRCX,FXACS,FXVCS,FYA,FYT,FRCY,FYACS,
C                             FYVCS,FZA,FZT,FRCZ,FZACS,FZVCS,MXA,MXT,
C                             MRCX,MXACS,MXVCS,MYA,MYT,MRCY,MYACS,MYVCS,
C                             MZA,MZT,MRCZ,MZACS,MZVCS,X,Y,Z,XD,YD,ZD
C
C     OUTPUTS :               UD,VD,WD,PD,QD,RD,GB,GR,MGR,MX,MY,MZ,FX,FY,
C                             FZ,XDD,YDD,ZDD,MXYZDD,U,V,W,QUATD,PHI,THT,
C                             PSI
C
C     BOTH :                  NCLEAR
C
C     UPDATES :               D. SISSOM   - CR # 011
C                             T. THORNTON - CR # 012
C                             T. THORNTON - CR # 018
C                             B. HILL     - CR # 030
C                             T. THORNTON - CR # 031
C                             T. THORNTON - CR # 033
C                             T. THORNTON - CR # 035
C                             T. THORNTON - CR # 037
C                             T. THORNTON - CR # 049
C                             T. THORNTON - CR # 050
C                             D. SMITH    - CR # 059
C                             D. SMITH    - CR # 060
C                             B. HILL     - CR # 062
C                             D. SMITH    - CR # 076
C                             R. RHYNE    - CR # 079
C                             B. HILL /   - CR # 081
C                             R. RHYNE
C                             R. RHYNE    - CR # 087
C                             B. HILL     - CR # 093
C
C-----------------------------------------------------------------------

      IMPLICIT DOUBLE PRECISION         (A-H)
      IMPLICIT DOUBLE PRECISION         (O-Z)

      DOUBLE PRECISION  CIM(9)        , CMT(9)        , GB(3)
      DOUBLE PRECISION  GR(3)         , MASS          , MGR
      DOUBLE PRECISION  MXYZ
      DOUBLE PRECISION  MXYZDD
      DOUBLE PRECISION  UXYZ(3)
```

```
      DOUBLE PRECISION  UXYZDD(3)      , XYZLCH(3)

C     LOCAL COMMON USED FOR CONSTANTS, LOCAL VARIABLES AND
C     INITIALIZATION FLAG

      SAVE              IMISL

C     COMMON "RMISSL" USED FOR MIDFLIGHT CAPABILITIES ONLY

      COMMON / RMISSL / XYZLCH

* DATA INITIALIZATION
$INCLUDE('^/INCLUDE/SSDATA39.DAT')
$INCLUDE('^/INCLUDE/SSDATA63.DAT')
$INCLUDE('^/INCLUDE/SSDATA28.DAT')

C        COMPUTE MISSILE LAUNCH POSITION IN INERTIAL FRAME

      CMI(1) = CIM(1)
      CMI(2) = CIM(4)
      CMI(3) = CIM(7)
      CMI(4) = CIM(2)
      CMI(5) = CIM(5)
      CMI(6) = CIM(8)
      CMI(7) = CIM(3)
      CMI(8) = CIM(6)
      CMI(9) = CIM(9)


C     DETERMINE LOCAL GRAVITY VECTOR

      MXYZ   = DSQRT ( X**2 + Y**2 + Z**2 )
      MGR    = GMU / MXYZ**2

      IF ( MXYZ.GT.0.0D0 ) THEN
         UXYZ(1) = X / MXYZ
         UXYZ(2) = Y / MXYZ
         UXYZ(3) = Z / MXYZ
      ELSE
         UXYZ(1) = 0.0D0
         UXYZ(2) = 0.0D0
         UXYZ(3) = 0.0D0
      ENDIF

C     CALCULATE GRAVITY VECTOR IN INERTIAL AND BODY FRAMES

      GR(1)  = - MGR*UXYZ(1)
      GR(2)  = - MGR*UXYZ(2)
      GR(3)  = - MGR*UXYZ(3)

      GB(1)  = CIM(1)*GR(1) + CIM(4)*GR(2) + CIM(7)*GR(3)
      GB(2)  = CIM(2)*GR(1) + CIM(5)*GR(2) + CIM(8)*GR(3)
      GB(3)  = CIM(3)*GR(1) + CIM(6)*GR(2) + CIM(9)*GR(3)

C     CALCULATE TOTAL FORCES AND MOMENTS

      FX     = FXACS + FXVCS
      FY     = FYACS + FYVCS
      FZ     = FZACS + FZVCS

C     MISSILE CLEARED THE LAUNCHER

      IF ( NCLEAR.EQ.1 ) THEN
         UD     = FX/MASS + GB(1)
```

```
         VD      = FY/MASS + GB(2)
         WD      = FZ/MASS + GB(3)
      ENDIF

C     TRANSFORM BODY ACCELERATIONS TO INERTIAL FRAME

      XDD = CMI(1)*UD + CMI(4)*VD + CMI(7)*WD
      YDD = CMI(2)*UD + CMI(5)*VD + CMI(8)*WD
      ZDD = CMI(3)*UD + CMI(6)*VD + CMI(9)*WD

      MXYZDD   = DSQRT ( XDD**2 + YDD**2 + ZDD**2 )
      IF ( MXYZDD.GT.0.0D0 ) THEN
         UXYZDD(1) = XDD / MXYZDD
         UXYZDD(2) = YDD / MXYZDD
         UXYZDD(3) = ZDD / MXYZDD
      ELSE
         UXYZDD(1) = 0.0D0
         UXYZDD(2) = 0.0D0
         UXYZDD(3) = 0.0D0
      ENDIF

      RETURN
      END
```

## B.2.24 Uumissl2.for

```
C-----------------------------------------------------------------------
      SUBROUTINE MISSIL2(T,QUAT,CIM,P,Q,R,IXX,IYY,IZZ,
     .                   MXACS,MXVCS,MYACS,MYVCS,MZACS,
     .                   MZVCS,XD,YD,ZD,NCLEAR,PD,QD,RD,
     .                   MX,MY,MZ,U,V,W,QUATD,PHI,THT,PSI)
C-----------------------------------------------------------------------
C
C     SUBROUTINE NAME :      MISSIL
C
C     AUTHOR(S) :            D. C. FOREMAN, A. P. BUKLEY
C
C     FUNCTION :             COMPUTES THE ROTATIONAL AND TRANSLATIONAL
C                            MISSILE ACCELERATIONS
C
C     CALLED FROM :          FORTRAN MAIN
C
C     SUBROUTINES CALLED :   FVDOT,FV2BXI
C
C     INPUTS :               T,QUAT,CIM,P,Q,R,IXX,IYY,IZZ,
C                            MXA,
C                            MXACS,MXVCS,MYACS,MYVCS,
C                            MZACS,MZVCS,XD,YD,ZD
C
C     OUTPUTS :              PD,QD,RD,MX,MY,MZ,
C                            U,V,W,QUATD,PHI,THT,
C                            PSI
C
C     BOTH :                 NCLEAR
C
C     UPDATES :              D. SISSOM   - CR # 011
C                            T. THORNTON - CR # 012
C                            T. THORNTON - CR # 018
C                            B. HILL     - CR # 030
C                            T. THORNTON - CR # 031
C                            T. THORNTON - CR # 033
C                            T. THORNTON - CR # 035
C                            T. THORNTON - CR # 037
C                            T. THORNTON - CR # 049
C                            T. THORNTON - CR # 050
C                            D. SMITH    - CR # 059
C                            D. SMITH    - CR # 060
C                            B. HILL     - CR # 062
C                            D. SMITH    - CR # 076
C                            R. RHYNE    - CR # 079
C                            B. HILL /   - CR # 081
C                            R. RHYNE
C                            R. RHYNE    - CR # 087
C                            B. HILL     - CR # 093
C
C-----------------------------------------------------------------------

      IMPLICIT REAL          (A-H)
      IMPLICIT REAL          (O-Z)

      REAL  CIM(9)         , CMI(9)
      REAL  IXX            , IYY
      REAL  IZZ
      REAL  MX             , MXACS
      REAL  MXVCS
      REAL  MY
      REAL  MYACS          , MYVCS
```

```
      REAL  MZ              , MZACS
      REAL  MZVCS           , PQR(3)
      REAL  QUAT(4)         , QUATD(4)
      REAL  XYZLCH(3)

C     LOCAL COMMON USED FOR CONSTANTS, LOCAL VARIABLES AND
C     INITIALIZATION FLAG

      SAVE                IMISL

C     COMMON "RMISSL" USED FOR MIDFLIGHT CAPABILITIES ONLY

      COMMON / RMISSL / XYZLCH

* DATA INITIALIZATION
$INCLUDE('^/INCLUDE/SSDATA39.DAT')
$INCLUDE('^/INCLUDE/SSDATA63.DAT')
$INCLUDE('^/INCLUDE/SSDATA28.DAT')

      DATA IMISL / 1 /

      IF (IMISL .EQ. 1) THEN

         IMISL = 0

C        COMPUTE MISSILE LAUNCH POSITION IN INERTIAL FRAME

         CMI(1) = CIM(1)
         CMI(2) = CIM(4)
         CMI(3) = CIM(7)
         CMI(4) = CIM(2)
         CMI(5) = CIM(5)
         CMI(6) = CIM(8)
         CMI(7) = CIM(3)
         CMI(8) = CIM(6)
         CMI(9) = CIM(9)

      ENDIF

C     CALCULATE TOTAL FORCES AND MOMENTS

      MX     = MXACS + MXVCS
      MY     = MYACS + MYVCS
      MZ     = MZACS + MZVCS

C     MISSILE CLEARED THE LAUNCHER

      IF ( NCLEAR.EQ.1 ) THEN
         PD     = MX/IXX + Q*R*((IYY-IZZ)/IXX)
         QD     = MY/IYY + R*P*((IZZ-IXX)/IYY)
         RD     = MZ/IZZ + P*Q*((IXX-IYY)/IZZ)
      ENDIF

C     COMPUTE QUATERNION DERIVATIVES

      PQR(1) = P
      PQR(2) = Q
      PQR(3) = R

      TMP1   = 0.0
      CALL FVDOT(PQR,TMP1,QUAT,QUATD)

C     COMPUTE BODY-TO-INERTIAL TRANSFORMATION MATRIX
```

```
      CALL FV2BXI(QUAT,TMP1,CMI)

      CIM(1) = CMI(1)
      CIM(2) = CMI(4)
      CIM(3) = CMI(7)
      CIM(4) = CMI(2)
      CIM(5) = CMI(5)
      CIM(6) = CMI(8)
      CIM(7) = CMI(3)
      CIM(8) = CMI(6)
      CIM(9) = CMI(9)

C     COMPUTE EULER ANGLES

      PHI    =  ATAN2(CIM(8),CIM(9))
      THT    = -ASIN (CIM(7))
      PSI    =  ATAN2(CIM(4),CIM(1))

C     TRANSFORM INERTIAL VELOCITY TO BODY FRAME

      U      = CIM(1)*XD + CIM(4)*YD + CIM(7)*ZD
      V      = CIM(2)*XD + CIM(5)*YD + CIM(8)*ZD
      W      = CIM(3)*XD + CIM(6)*YD + CIM(9)*ZD

      RETURN
      END
```

## B.2.25 Uummk.for

```
C-----------------------------------------------------------------------
      SUBROUTINE MMK(A,NA,B,NB,C,NC,RM)
C-----------------------------------------------------------------------
C
C     SUBROUTINE NAME :      MMK
C
C     AUTHOR(S) :            J. SHEEHAN
C
C     FUNCTION  :            GENERATES A DIRECTION COSINE MATRIX
C                            BY ROTATING IN ORDER:
C                              1) ANGLE C ABOUT THE NC AXIS
C                              2) ANGLE B ABOUT THE NB AXIS
C                              3) ANGLE A ABOUT THE NA AXIS
C
C     CALLED FROM  :         UTILITY SUBROUTINE
C
C     SUBROUTINES CALLED :   ROTMX, MMLXY
C
C     INPUTS :               A,NA,B,NB,C,NC
C
C     OUTPUTS :              RM
C
C     UPDATES :              D. SMITH    - CR # 59
C
C-----------------------------------------------------------------------
C
      IMPLICIT DOUBLE PRECISION (A-H)
      IMPLICIT DOUBLE PRECISION (O-Z)
C
      DIMENSION AM(3,3), BM(3,3), CM(3,3), RM(3,3), T(9)
C
      CALL ROTMX(A,NA,AM)
      CALL ROTMX(B,NB,BM)
      CALL ROTMX(C,NC,CM)
C
      CALL MMLXY(BM,CM,T)
      CALL MMLXY(AM,T,RM)
C
      RETURN
      END
```

## B.2.26 Uummlxy.for

```
C------------------------------------------------- ------------------
      SUBROUTINE MMLXY(X,Y,Z)
C-----------------------------------------------------------------------
C
C     SUBROUTINE NAME :      MMLXY
C
C     AUTHOR(S) :            J. SHEEHAN
C
C     FUNCTION  :            MULTIPLY TWO 3X3 MATRICES
C
C     CALLED FROM  :         UTILITY SUBROUTINE
C
C     SUBROUTINES CALLED :   NONE
C
C     INPUTS :               X, Y
C
C     OUTPUTS :              Z
C
C     UPDATES :              D. SMITH    - CR # 59
C
C-----------------------------------------------------------------------
C
      IMPLICIT DOUBLE PRECISION (A-H)
      IMPLICIT DOUBLE PRECISION (O-Z)
C
      DIMENSION X(3,3), Y(3,3), Z(3,3)
C
C     Z(I,J) = X(I,1)*Y(1,J) + X(I,2)*Y(2,J) + X(I,3)*Y(3,J)
C
      Z(1,1) = X(1,1)*Y(1,1) + X(1,2)*Y(2,1) + X(1,3)*Y(3,1)
      Z(2,1) = X(2,1)*Y(1,1) + X(2,2)*Y(2,1) + X(2,3)*Y(3,1)
      Z(3,1) = X(3,1)*Y(1,1) + X(3,2)*Y(2,1) + X(3,3)*Y(3,1)
      Z(1,2) = X(1,1)*Y(1,2) + X(1,2)*Y(2,2) + X(1,3)*Y(3,2)
      Z(2,2) = X(2,1)*Y(1,2) + X(2,2)*Y(2,2) + X(2,3)*Y(3,2)
      Z(3,2) = X(3,1)*Y(1,2) + X(3,2)*Y(2,2) + X(3,3)*Y(3,2)
      Z(1,3) = X(1,1)*Y(1,3) + X(1,2)*Y(2,3) + X(1,3)*Y(3,3)
      Z(2,3) = X(2,1)*Y(1,3) + X(2,2)*Y(2,3) + X(2,3)*Y(3,3)
      Z(3,3) = X(3,1)*Y(1,3) + X(3,2)*Y(2,3) + X(3,3)*Y(3,3)
C
      RETURN
      END
```

## B.2.27 Uunavig.for

```
C-----------------------------------------------------------------------
      SUBROUTINE NAVIG(T,MASS,DELPHI,DELTHT,DELPSI,DELU,DELV,DELW,GR,
     .                 QS1,CIE,SP,SQ,SR,SUD,SVD,SWD,VMIR,RMIR,TI2M,
     .                 SPHI,STHT,SPSI,SU,SV,SW,AT,VMI,RMI)
C-----------------------------------------------------------------------
C
C     SUBROUTINE NAME :      NAVIG
C
C     AUTHOR(S) :            B. HILL
C
C     FUNCTION :             COMPUTES THE QUATERNIONS AND TRANSFORMATION
C                            MATRICES USING DELTA ANGLES SENSED BY THE
C                            GYRO. COMPUTES THE POSITION AND VELOCITY IN
C                            INERTIAL AND EARTH-CENTERED FRAMES.
C                            COMPUTES SENSED BODY RATES, EULER ANGLES AND
C                            THE GRAVITY-COMPENSATED ACCELERATION.
C
C     CALLED FROM :          FORTRAN MAIN
C
C     SUBROUTINES CALLED :   NONE
C
C     INPUTS :               T,MASS,DELPHI,DELTHT,DELPSI,DELU,DELV,DELW,
C                            GR,CIE
C
C     OUTPUTS :              QS1,TI2M,SPHI,STHT,SPSI,SU,SV,SW,AT,VMI,RMI
C
C     BOTH :                 SP,SQ,SR,SUD,SVD,SWD,VMIR,RMIR
C
C     UPDATES :              T. THORNTON - CR # 016
C                            B. HILL     - CR # 019
C                            B. HILL     - CR # 022
C                            B. HILL     - CR # 030
C                            T. THORNTON - CR # 033
C                            T. THORNTON - CR # 037
C                            D. SMITH    - CR # 059
C                            B. HILL     - CR # 062
C                            D. SISSOM   - CR # 069
C                            D. SMITH    - CR # 070
C                            D. SMITH    - CR # 075
C                            D. SMITH    - CR # 076
C                            B. HILL /   - CR # 081
C                            R. RHYNE
C                            R. RHYNE    - CR # 087
C                            B. HILL     - CR # 089
C                            D. SMITH    - CR # 092
C                            B. HILL     - CR # 093
C
C-----------------------------------------------------------------------

      IMPLICIT DOUBLE PRECISION          (A-H)
      IMPLICIT DOUBLE PRECISION          (O-Z)

      DOUBLE PRECISION  VMIR(3)        , RMIR(3)        , VMI(3)
      DOUBLE PRECISION  RMI(3)         , TI2M(9)
      DOUBLE PRECISION  GR(3)          , CIE(9)         , AT(3)
      DOUBLE PRECISION  QS1(4)         , MASS           , GRAVG(3)
      DOUBLE PRECISION  GRLAST(3)

C     LOCAL COMMON USED FOR LOCAL VARIABLES AND
C     INITIALIZATION FLAG
```

```
      SAVE                INAVIG

C     COMMON "RNAVIG" USED FOR MIDFLIGHT CAPABILITIES ONLY

      COMMON / RNAVIG / GRLAST , T0NAV  , MNAV   , DTX0   , DTY0   ,
     .                  DTZ0

      DATA INAVIG / 1 /

      IF ( INAVIG.EQ.1 ) THEN

         INAVIG = 0

         QS1M = DSQRT(QS1(1)**2 + QS1(2)**2 + QS1(3)**2 + QS1(4)**2)
         IF ( QS1M .EQ. 0. ) THEN

C           COMPUTE QUATERNION COMPONENTS

            SITH0 = DSIN(STHT/2.0D0)
            COTH0 = DCOS(STHT/2.0D0)
            SIPS0 = DSIN(SPSI/2.0D0)
            COPS0 = DCOS(SPSI/2.0D0)
            SIPH0 = DSIN(SPHI/2.0D0)
            COPH0 = DCOS(SPHI/2.0D0)

C           CALCULATE QUATERNIONS

            QS1(4) = COPS0*COTH0*COPH0 + SIPS0*SITH0*SIPH0
            QS1(1) = COPS0*COTH0*SIPH0 - SIPS0*SITH0*COPH0
            QS1(2) = COPS0*SITH0*COPH0 + SIPS0*COTH0*SIPH0
            QS1(3) = -COPS0*SITH0*SIPH0 + SIPS0*COTH0*COPH0

C           COMPUTE TRANSFORMATION MATRICES

C            D1 = QS1(4) * QS1(4)
C            D2 = QS1(1) * QS1(1)
C            D3 = QS1(2) * QS1(2)
C            D4 = QS1(3) * QS1(3)
C            D5 = QS1(1) * QS1(2)
C            D6 = QS1(1) * QS1(3)
C            D7 = QS1(1) * QS1(4)
C            D8 = QS1(2) * QS1(3)
C            D9 = QS1(2) * QS1(4)
C            D10= QS1(3) * QS1(4)
C            TI2M(1) = D1 + D2 - D3 - D4
C            TI2M(2) = 2.0D0*(D5 - D10)
C            TI2M(3) = 2.0D0*(D6 + D9)
C            TI2M(4) = 2.0D0*(D5 + D10)
C            TI2M(5) = D1 - D2 + D3 - D4
C            TI2M(6) = 2.0D0*(D8 - D7)
C            TI2M(7) = 2.0D0*(D6 - D9)
C            TI2M(8) = 2.0D0*(D8 + D7)
C            TI2M(9) = D1 - D2 - D3 + D4

         ENDIF
      ENDIF

      DTDEL  = T - T0NAV
      T0NAV  = T

C     COMPUTE CORRECTED INTEGRAL ANGLES

      DTX    = 0.5D0*DELPHI
      DTY    = 0.5D0*DELTHT
```

```
      DTZ    = 0.5D0*DELPSI

C     INTERMEDIATE COMPUTATIONS

      PP0    = DTX**2 + DTY**2 + DTZ**2
      PP1    = ( PP0*DTX + DTY*DTZ0 - DTZ*DTY0 ) / 6.0D0
      PP2    = ( PP0*DTY + DTZ*DTX0 - DTX*DTZ0 ) / 6.0D0
      PP3    = ( PP0*DTZ + DTX*DTY0 - DTY*DTX0 ) / 6.0D0

C     SET PAST VALUES OF CORRECTED INCREMENTAL ANGLES TO PRESENT

      DTX0   = DTX
      DTY0   = DTY
      DTZ0   = DTZ

C     UPDATE CURRENT VALUES OF CORRECTED INCREMENTAL ANGLE

      DTX    = DTX - PP1
      DTY    = DTY - PP2
      DTZ    = DTZ - PP3

C     CALCULATE DELTA QUATERNIONS

      DUM    = -0.5D0*PP0
      PQ0    = DUM*QS1(4) - DTX*QS1(1) - DTY*QS1(2) - DTZ*QS1(3)
      PQ1    = DTX*QS1(4) + DUM*QS1(1) + DTZ*QS1(2) - DTY*QS1(3)
      PQ2    = DTY*QS1(4) - DTZ*QS1(1) + DUM*QS1(2) + DTX*QS1(3)
      PQ3    = DTZ*QS1(4) + DTY*QS1(1) - DTX*QS1(2) + DUM*QS1(3)

C     UPDATE QUATERNIONS

      QS1(4) = QS1(4) + PQ0
      QS1(1) = QS1(1) + PQ1
      QS1(2) = QS1(2) + PQ2
      QS1(3) = QS1(3) + PQ3

C     NORMALIZE QUATERNIONS

      DQ     = 1.0d0 + 0.5D0*(1.0D0-QS1(4)**2-QS1(1)**2
     1                              -QS1(2)**2-QS1(3)**2)
      QS1(1) = QS1(1)*(DQ)
      QS1(2) = QS1(2)*(DQ)
      QS1(3) = QS1(3)*(DQ)
      QS1(4) = QS1(4)*(DQ)

C     COMPUTE TRANSFORMATION MATRICES

      D1 = QS1(4) * QS1(4)
      D2 = QS1(1) * QS1(1)
      D3 = QS1(2) * QS1(2)
      D4 = QS1(3) * QS1(3)
      D5 = QS1(1) * QS1(2)
      D6 = QS1(1) * QS1(3)
      D7 = QS1(1) * QS1(4)
      D8 = QS1(2) * QS1(3)
      D9 = QS1(2) * QS1(4)
      D10= QS1(3) * QS1(4)
      TI2M(1) = D1 - D2 - D3 - D4
      TI2M(2) = 2.0D0*(D5 - D10)
      TI2M(3) = 2.0D0*(D6 + D9)
      TI2M(4) = 2.0D0*(D5 + D10)
      TI2M(5) = D1 - D2 + D3 - D4
      TI2M(6) = 2.0D0*(D8 - D7)
      TI2M(7) = 2.0D0*(D6 - D9)
```

```
      TI2M(8) = 2.0D0*(D8 + D7)
      TI2M(9) = D1 - D2 - D3 + D4

C     COMPUTE SENSED EULER ANGLES

      SPHI   =  DATAN2(TI2M(8),TI2M(9))
      STHT   = -DASIN (TI2M(7))
      SPSI   =  DATAN2(TI2M(4),TI2M(1))

C     CALCULATE SENSED ANGULAR RATES AND ACCELERATIONS IN BODY FRAME

      IF ( DTDEL.GT.0.0D0 ) THEN
         SP     = DELPHI/DTDEL
         SQ     = DELTHT/DTDEL
         SR     = DELPSI/DTDEL
         SUD    = DELU/DTDEL
         SVD    = DELV/DTDEL
         SWD    = DELW/DTDEL
      ENDIF

C     TRANSFORM THE SENSED BODY ACCELERATIONS TO THE INERTIAL FRAME (
DOES
C     NOT INCLUDE GRAVITY )
C     NOTE AT = (SUD,SVD,SWD) * TRANSPOSE[TM2I]

      AT(1) = TI2M(1)*SUD + TI2M(2)*SVD + TI2M(3)*SWD
      AT(2) = TI2M(4)*SUD + TI2M(5)*SVD + TI2M(6)*SWD
      AT(3) = TI2M(7)*SUD + TI2M(8)*SVD + TI2M(9)*SWD

C     TRANSFORM THE SENSED DELTA VELOCITIES INTO INERTIAL COORDINATES

      DELXD  = TI2M(1)*DELU + TI2M(2)*DELV + TI2M(3)*DELW
      DELYD  = TI2M(4)*DELU + TI2M(5)*DELV + TI2M(6)*DELW
      DELZD  = TI2M(7)*DELU + TI2M(8)*DELV + TI2M(9)*DELW

C     DETERMINE AVERAGE GRAVITY VECTOR OVER PREVIOUS INTERVAL

      IF ( DTDEL.NE.0.0D0 ) THEN
         GRAVG(1) = 0.5D0*( GRLAST(1) + GR(1) )
         GRAVG(2) = 0.5D0*( GRLAST(2) + GR(2) )
         GRAVG(3) = 0.5D0*( GRLAST(3) + GR(3) )
      ELSE
         GRAVG(1) = GR(1)
         GRAVG(2) = GR(2)
         GRAVG(3) = GR(3)
      ENDIF

C     SAVE GRAVITY VECTOR FOR USE ON NEXT PASS

      GRLAST(1) = GR(1)
      GRLAST(2) = GR(2)
      GRLAST(3) = GR(3)

C     GRAVITY COMPENSATE THE SENSED DELTA VELOCITY COMPONENTS

      DELXD  = DELXD + DTDEL*GRAVG(1)
      DELYD  = DELYD + DTDEL*GRAVG(2)
      DELZD  = DELZD + DTDEL*GRAVG(3)

C     COMPUTE SENSED MISSILE POSITION AND VELOCITY IN INERTIAL FRAME

      RMIR(1) = RMIR(1) + DTDEL*(VMIR(1) + 0.5D0*DELXD)
      RMIR(2) = RMIR(2) + DTDEL*(VMIR(2) + 0.5D0*DELYD)
      RMIR(3) = RMIR(3) + DTDEL*(VMIR(3) + 0.5D0*DELZD)
```

```
      VMIR(1) = VMIR(1) + DELXD
      VMIR(2) = VMIR(2) + DELYD
      VMIR(3) = VMIR(3) + DELZD

C     TRANSFORM SENSED INERTIAL VELOCITIES INTO BODY FRAME

      SU      = TI2M(1)*VMIR(1) + TI2M(4)*VMIR(2) + TI2M(7)*VMIR(3)
      SV      = TI2M(2)*VMIR(1) + TI2M(5)*VMIR(2) + TI2M(8)*VMIR(3)
      SW      = TI2M(3)*VMIR(1) + TI2M(6)*VMIR(2) + TI2M(9)*VMIR(3)

C     TRANSFORM THE SENSED INERTIAL STATES INTO EARTH COORDINATE FRAME

      RMI(1) = CIE(1)*RMIR(1) + CIE(4)*RMIR(2) + CIE(7)*RMIR(3)
      RMI(2) = CIE(2)*RMIR(1) + CIE(5)*RMIR(2) + CIE(8)*RMIR(3)
      RMI(3) = CIE(3)*RMIR(1) + CIE(6)*RMIR(2) + CIE(9)*RMIR(3)

      VMI(1) = CIE(1)*VMIR(1) + CIE(4)*VMIR(2) + CIE(7)*VMIR(3)
      VMI(2) = CIE(2)*VMIR(1) + CIE(5)*VMIR(2) + CIE(8)*VMIR(3)
      VMI(3) = CIE(3)*VMIR(1) + CIE(6)*VMIR(2) + CIE(9)*VMIR(3)

      RETURN
      END
```

## B.2.28 Uunorm.for

```
C-----------------------------------------------------------------------
      SUBROUTINE spNORM(SD,MN,ISEED,RDN)
C-----------------------------------------------------------------------
C
C     SUBROUTINE NAME :      NORM
C
C     AUTHOR(S) :            D. F. SMITH
C
C     FUNCTION :             GENERATES NORMALLY DISTRIBUTED RANDOM
C                            NUMBERS USING THE BOX-MULLER TRANSFORMATION
C
C     CALLED FROM :          UTILITY SUBROUTINE
C
C     SUBROUTINES CALLED :   RAN0
C
C     INPUTS :               SD,MN
C
C     OUTPUTS :              RDN
C
C     BOTH :                 ISEED
C
C     UPDATES :              D. SMITH     - CR # 082
C                            R. RHYNE     - CR # 087
C
C-----------------------------------------------------------------------

      IMPLICIT REAL          (A-H)
      IMPLICIT REAL          (O-Z)

      INTEGER*4 ISEED

      REAL  MN

      COMMON / NORCOM / GSET    , ISET

      DATA ONE    / 1.0e0 /
      DATA TWO    / 2.0e0 /

C     IF A SPARE RANDOM NUMBER IS NOT AVAILABLE FROM THE PREVIOUS PASS
C     GENERATE TWO NEW ONES

      IF ( ISET.EQ.0 ) THEN

C        GET TWO UNIFORM RANDOM NUMBERS WITHIN THE SQUARE EXTENDING
C        FROM -1 TO 1 IN EACH DIRECTION


    1    V1      = TWO*spRAN0(ISEED) - ONE
         V2      = TWO*spRAN0(ISEED) - ONE

C        SEE IF THEY ARE WITHIN THE UNIT CIRCLE . IF NOT , TRY AGAIN .

         R       = V1*V1 + V2*V2
         IF ( R.GE.ONE ) GO TO 1

C        PERFORM BOX-MULLER TRANSFORMATION TO GENERATE TWO GAUSSIAN
C        RANDOM NUMBERS . RETURN ONE AND SAVE THE OTHER FOR THE NEXT
C        PASS .

         FAC     = SQRT ( -TWO*ALOG(R)/R )
         GSET    = FAC*V1
```

```
         RDN     = MN + SD*FAC*V2
         ISET    = 1

C     USE GAUSSIAN RANDOM NUMBER CARRIED OVER FROM PREVIOUS PASS .

      ELSE IF ( ISET.EQ.1 ) THEN
         RDN     = MN + SD*GSET
         ISET    = 0
      ENDIF

      RETURN
      END
```

## B.4.29 Uuobtarg.for

```
C------- -------------------------------------------------------------
      SUBROUTINE OBTARG(T,GRTEST,RTEST,VTEST)
C-----------------------------------------------------------------------
C
C     SUBROUTINE NAME :      OBTARG
C
C     AUTHOR(S) :            D. SISSOM
C
C     FUNCTION :             COMPUTES THE ONBOARD TARGET ESTIMATES
C
C     CALLED FROM :          FORTRAN MAIN
C
C     SUBROUTINES CALLED :   NONE
C
C     INPUTS :               T,GRTEST
C
C     BOTH :                 RTEST,VTEST
C
C     UPDATES :              B. HILL      - CR # 030
C                            T. THORNTON  - CR # 045
C                            B. HILL      - CR # 055
C                            D. SMITH     - CR # 059
C                            B. HILL      - CR # 062
C                            D. SISSOM    - CR # 069
C                            D. SMITH     - CR # 070
C                            B. HILL /    - CR # 081
C                            R. RHYNE
C                            R. RHYNE     - CR # 087
C                            D. SISSOM    - CR # 091
C                            B. HILL      - CR # 093
C
C-----------------------------------------------------------------------
C
      IMPLICIT DOUBLE PRECISION          (A-H)
      IMPLICIT DOUBLE PRECISION          (O-Z)

      DOUBLE PRECISION  RTEST(3)
      DOUBLE PRECISION  GRTEST(3), VTEST(3)
      DOUBLE PRECISION  GRTPST(3)      , GRTAOB(3)
      DOUBLE PRECISION  TARPOS(3)      , TARVEL(3)

      INTEGER           FIRST2

C     COMMON "ROBTRG" USED FOR MIDFLIGHT CAPABILITIES ONLY

      COMMON / ROBTRG / FIRST2, TL2, GRTPST

* DATA INITIALIZATION
$INCLUDE('^/INCLUDE/SSDATA65.DAT')

      IF ( FIRST2 .EQ. 1 ) THEN
         FIRST2 = 0
         TL2 = T

C        INITIALIZE ESTIMATED TARGET STATES

         DO 45 IAXIS = 1, 3
            RTEST(IAXIS) = TARPOS(IAXIS)
            VTEST(IAXIS) = TARVEL(IAXIS)
   45    CONTINUE
      ELSE
```

```
C        INTEGRATE TARGET ACCELERATION AND VELOCITY USING AVERAGE
C        GRAVITY VECTOR OVER LAST INTERVAL

         TDELT  = T - TL2
         TL2    = T
         DO 2 I = 1,3
            GRTAOB(I) = 0.5D0 * ( GRTEST(I) + GRTPST(I) )
            RTEST(I)  = RTEST(I) + VTEST(I)*TDELT +
                        0.5D0*GRTAOB(I)*TDELT*TDELT
            VTEST(I)  = VTEST(I) + GRTAOB(I)*TDELT
    2    CONTINUE
       ENDIF

C      SAVE GRAVITY VECTOR FOR USE ON NEXT PASS

       DO 3 I = 1,3
          GRTPST(I) = GRTEST(I)
    3  CONTINUE

       RETURN
       END
```

## B.2.30 Uuran.for

```
C-----------------------------------------------------------------------
      REAL FUNCTION RAN(ISEED)
C-----------------------------------------------------------------------
C
C     SUBROUTINE NAME :      RAN
C
C     AUTHOR(S) :            D. F. SMITH
C
C     FUNCTION :             GENERATES A UNIFORMLY DISTRIBUTED RANDOM
C                            NUMBER
C
C     CALLED FROM :          UTILITY SUBROUTINE
C
C     SUBROUTINES CALLED :   NONE
C
C     INPUTS :               NONE
C
C     OUTPUTS :              RAN
C
C     BOTH :                 ISEED
C
C     UPDATES :              NONE
C
C-----------------------------------------------------------------------
      integer*4 iseed

      iseed = 69069*iseed + 1
      ran = abs(float(iseed)/2147483647.0)
      RETURN
      END
```

## B.2.31 Uuran0.for

```
C-----------------------------------------------------------------------
      DOUBLE PRECISION FUNCTION RAN0(ISEED)
C-----------------------------------------------------------------------
C
C     SUBROUTINE NAME :      RAN0
C
C     AUTHOR(S) :            D. F. SMITH
C
C     FUNCTION :             GENERATES A UNIFORMLY DISTRIBUTED RANDOM
C                            NUMBER BETWEEN 0 AND 1 USING THE SYSTEM
C                            ROUTINE RAN(ISEED) . THE BUFFER IN COMMON
C                            BLOCK RANCOM IS INITIALIZED BY CALLING
C                            ROUTINE RANIT .
C
C     CALLED FROM :          UTILITY SUBROUTINE
C
C     SUBROUTINES CALLED :   RAN
C
C     INPUTS :               NONE
C
C     OUTPUTS :              RAN0
C
C     BOTH :                 ISEED
C
C     UPDATES :              NONE
C
C-----------------------------------------------------------------------
C
C     NOTE : IMPLICIT DOUBLE PRECISION IS NOT NEEDED SINCE THE OUTPUT
C            OF RAN IS SINGLE PRECISION

      integer*4 iseed
      COMMON / RANCOM /          RANSEQ(97),      RANLST

C     USE PREVIOUSLY SAVED RANDOM NUMBER AS BUFFER INDEX AND MAKE
C     SURE ARRAY BOUNDS ARE NOT EXCEEDED .

      J      = 1 + INT ( 97.0*RANLST )
      IF ( J.LT.1 .OR. J.GT.97 ) THEN
         CALL OUTMES(' RANDOM NUMBER OUT OF BOUNDS IN RAN0')
      END IF

C     RETRIEVE RANDOM NUMBER FROM BUFFER FOR OUTPUT AND SAVE IT FOR
C     USE AS AN INDEX ON THE NEXT PASS .

      RANLST = RANSEQ(J)
      RAN0   = DBLE ( RANLST )

C     LOAD A NEW RANDOM NUMBER IN THE SLOT JUST VACATED .

      RANSEQ(J) = RAN ( ISEED )

      RETURN
      END
```

## B.2.32 Uurelat.for

```
C-----------------------------------------------------------------------
      SUBROUTINE RELAT(RTIC,VTIC,X,Y,Z,XD,YD,ZD,Q,R,CIM,CMS,RRELTR,
     .                 MAGRTR,VRELTR,MGRDTR,MAGLOS,LAMTRU,LAMDXX,
     .                 LAMDTR,LAMSEK,LAMDSK,TGOTR,RRELM,VRELM)
C-----------------------------------------------------------------------
C
C     SUBROUTINE NAME :      RELAT
C
C     AUTHOR(S) :            T. THORNTON
C
C     FUNCTION :             COMPUTES RELATIVE RANGE, RANGE RATE,
C                            TIME-TO-GO,LOS ANGLES AND RATES
C
C     CALLED FROM :          FORTRAN MAIN
C
C     SUBROUTINES CALLED :   NONE
C
C     INPUTS :               RTIC,VTIC,X,Y,Z,XD,YD,ZD,Q,R,CIM,CMS
C
C     OUTPUTS :              RRELTR,MAGRTR,VRELTR,MGRDTR,MAGLOS,LAMTRU,
C                            LAMDXX,LAMDTR,LAMSEK,LAMDSK,TGOTR,RRELM,
C                            VRELM,CAZ,CEL
C
C     UPDATES :              T. THORNTON - CR # 037
C                            B. HILL     - CR # 038
C                            T. THORNTON - CR # 048
C                            D. SMITH    - CR # 059
C                            B. HILL /   - CR # 081
C                            R. RHYNE
C                            D. SISSOM   - CR # 091
C                            B. HILL     - CR # 093
C
C-----------------------------------------------------------------------

      IMPLICIT DOUBLE PRECISION (A-H)
      IMPLICIT DOUBLE PRECISION (O-Z)

      REAL   CIM(9)        , XD,YD,ZD,Q,R
      DOUBLE PRECISION CMS(9)       , MAGLOS
      DOUBLE PRECISION RTIC(5,3)     , RRELTR(3)    , URRELT(3)
      DOUBLE PRECISION MAGRTR        , VTIC(5,3)    , VRELTR(3)
      DOUBLE PRECISION MAGVTR        , MGRDTR       , RRELM(3)
      DOUBLE PRECISION VRELM(3)      , LAMTRU(2)    , LAMDXX(2)
      DOUBLE PRECISION LAMDTR(2)     , RRELS(3)     , VRELS(3)
      DOUBLE PRECISION LAMSEK(2)     , LAMDSK(2)

      INTEGER          SEKTYP

* DATA INITIALIZATION
$INCLUDE('^/INCLUDE/SSDATA50.DAT')
$INCLUDE('^/INCLUDE/SSDATA66.DAT')
$INCLUDE('^/INCLUDE/SSDATA21.DAT')

C     COMPUTE RELATIVE RANGE, RANGE RATE, AND TIME-TO-GO

      RRELTR(1) = RTIC(1,1) - X
      RRELTR(2) = RTIC(1,2) - Y
      RRELTR(3) = RTIC(1,3) - Z

      MAGRTR = DSQRT(RRELTR(1)**2 + RRELTR(2)**2 + RRELTR(3)**2)
      URRELT(1) = RRELTR(1)/MAGRTR
```

```
      URRELT(2) = RRELTR(2)/MAGRTR
      URRELT(3) = RRELTR(3)/MAGRTR

      VRELTR(1) = VTIC(1,1) - XD
      VRELTR(2) = VTIC(1,2) - YD
      VRELTR(3) = VTIC(1,3) - ZD

      MAGVTR = DSQRT(VRELTR(1)**2 + VRELTR(2)**2 + VRELTR(3)**2)

      MGRDTR = VRELTR(1)*URRELT(1) + VRELTR(2)*URRELT(2) +
     .         VRELTR(3)*URRELT(3)
      VRDRRT = VRELTR(1)*RRELTR(1) + VRELTR(2)*RRELTR(2) +
     .         VRELTR(3)*RRELTR(3)

      TGOTR = -VRDRRT/(MAGVTR**2)

C     COMPUTE LOS ANGLES AND RATES IN BODY FRAME

      RRELM(1) = RRELTR(1)*CIM(1) + RRELTR(2)*CIM(4) + RRELTR(3)*CIM(7)
      RRELM(2) = RRELTR(1)*CIM(2) + RRELTR(2)*CIM(5) + RRELTR(3)*CIM(8)
      RRELM(3) = RRELTR(1)*CIM(3) + RRELTR(2)*CIM(6) + RRELTR(3)*CIM(9)

      VRELM(1) = VRELTR(1)*CIM(1) + VRELTR(2)*CIM(4) + VRELTR(3)*CIM(7)
      VRELM(2) = VRELTR(1)*CIM(2) + VRELTR(2)*CIM(5) + VRELTR(3)*CIM(8)
      VRELM(3) = VRELTR(1)*CIM(3) + VRELTR(2)*CIM(6) + VRELTR(3)*CIM(9)

      LAMTRU(1) = DATAN2(-RRELM(3),RRELM(1))
      LAMTRU(2) = DATAN2(RRELM(2),RRELM(1))
      LAMDXX(1) = (RRELM(3)*VRELM(1) - RRELM(1)*VRELM(3)) /
     .            (RRELM(1)**2 + RRELM(3)**2)
      LAMDXX(2) = (RRELM(1)*VRELM(2) - RRELM(2)*VRELM(1)) /
     .            (RRELM(1)**2 + RRELM(2)**2)
      LAMDTR(1) = LAMDXX(1) - Q
      LAMDTR(2) = LAMDXX(2) - R

C     COMPUTE LOS ANGLES AND RATES IN SEEKER FRAME

      RRELS(1) = RRELM(1)*CMS(1) + RRELM(2)*CMS(4) + RRELM(3)*CMS(7)
      RRELS(2) = RRELM(1)*CMS(2) + RRELM(2)*CMS(5) + RRELM(3)*CMS(8)
      RRELS(3) = RRELM(1)*CMS(3) + RRELM(2)*CMS(6) + RRELM(3)*CMS(9)

      VRELS(1) = VRELM(1)*CMS(1) + VRELM(2)*CMS(4) + VRELM(3)*CMS(7)
      VRELS(2) = VRELM(1)*CMS(2) + VRELM(2)*CMS(5) + VRELM(3)*CMS(8)
      VRELS(3) = VRELM(1)*CMS(3) + VRELM(2)*CMS(6) + VRELM(3)*CMS(9)

      LAMSEK(1) = DATAN2(-RRELS(3),RRELS(1))
      LAMSEK(2) = DATAN2(RRELS(2),RRELS(1))
      MAGLOS    = DABS(DATAN2(DSQRT(RRELS(2)**2 + RRELS(3)**2),
     .            RRELS(1)))/DTR
      LAMDSK(1) = (RRELS(3)*VRELS(1) - RRELS(1)*VRELS(3)) /
     .            (RRELS(1)**2 + RRELS(3)**2)
      LAMDSK(2) = (RRELS(1)*VRELS(2) - RRELS(2)*VRELS(1)) /
     .            (RRELS(1)**2 + RRELS(2)**2)

      RETURN
      END
```

## B.2.33 Uuresp2r.for

```
C-----------------------------------------------------------------------
      SUBROUTINE RESP2R ( DT,WD,ZD,CILL,CIL,CI,COLL,COL,CO )
C-----------------------------------------------------------------------
C
C     SUBROUTINE NAME :      RESP2R
C
C     AUTHOR(S) :            D. F. SMITH
C
C     FUNCTION :             Given a second order continuous filter of
C                            the form
C
C                                                WD**2
C                            G(s) = ------------------------------
C                                   s**2 + 2.0*ZD*WD*s + WD**2
C
C                            compute a digital filter which yields the
C                            same ramp response . The digital filter has
C                            the transfer function
C
C                                   CI*z**2 + CIL*z + CILL
C                            G(z) = ------------------------
C                                   CO*z**2 + COL*z + COLL
C
C     CALLED FROM :          UTILITY ROUTINE
C
C     SUBROUTINES CALLED :   NONE
C
C     INPUTS :               DT,WD,ZD
C
C     OUTPUTS :              CILL,CIL,CI,COLL,COL,CO
C
C     UPDATES :              NONE
C
C-----------------------------------------------------------------------

      IMPLICIT DOUBLE PRECISION         (A-H)
      IMPLICIT DOUBLE PRECISION         (O-Z)

      DATA      ONE   / 1.0D0 /
      DATA      TWO   / 2.0D0 /

C     Underdamped filter

      IF ( ZD.LT.ONE ) THEN
         A      =   WD*ZD
         B      =   WD*DSQRT ( ONE - ZD**2 )
         TMP1   =   DEXP ( - A*DT )
         TMP2   =   DEXP ( - TWO*A*DT )
         TMP3   =   DCOS ( B*DT )
         TMP4   =   DSIN ( B*DT )
         TMP5   =   A*A + B*B
         TMP6   =   TMP1*TMP4*( A*A - B*B )/B
         CI     =   TMP5*DT - TWO*A + TWO*A*TMP1*TMP3 + TMP6
         CIL    =   TWO*( A - DT*TMP1*TMP3*TMP5 - TMP6 - A*TMP2 )
         CILL   =   TMP6 - TWO*A*TMP1*TMP3 + TMP2*( TWO*A + TMP5*DT )
         CO     =   TMP5*DT
         COL    = - TWO*TMP1*TMP3*CO
         COLL   =   TMP2*CO
      END IF

C     Critically damped filter
```

```
      IF ( ZD.EQ.ONE ) THEN
         A      =   WD
         TMP1   =   DEXP ( - A*DT )
         TMP2   =   DEXP ( - TWO*A*DT )
         TMP3   =   TWO + A*DT
         TMP4   = - TWO + A*DT
         CI     =   TMP1*TMP3 + TMP4
         CIL    =   TWO*( ONE - TWO*A*DT*TMP1 - TMP2 )
         CILL   =   TMP1*TMP4 + TMP2*TMP3
         CO     =   A*DT
         COL    = - CO*TWO*TMP1
         COLL   =   CO*TMP2
      END IF

C     Overdamped filter

      IF ( ZD.GT.ONE ) THEN
         TMP5   =   DSQRT ( ZD**2 - ONE )
         A      =   WD*TMP5
         B      =   WD/TMP5
         ASQ    =   A*A
         BSQ    =   B*B
         EXPA   =   DEXP ( - A*DT )
         EXPB   =   DEXP ( - B*DT )
         TMP1   =   A*DT + EXPA - ONE
         TMP2   =   B*DT + EXPB - ONE
         TMP3   =   ONE + A*DT
         TMP4   =   ONE + B*DT
         CI     =   ASQ*TMP2 - BSQ*TMP1
         CIL    =   ASQ*( ONE - EXPA*TMP2 - EXPB*TMP4 )
     .             - BSQ*( ONE - EXPB*TMP1 - EXPA*TMP3 )
         CILL   =   ASQ*EXPA*( EXPB*TMP4 - ONE )
     .             - BSQ*EXPB*( EXPA*TMP3 - ONE )
         CO     =   A*B*DT*( A - B )
         COL    = - CO*( EXPA + EXPB )
         COLL   =   CO*EXPA*EXPB
      END IF

      RETURN
      END
```

## B.2.34 Uuresthr.for

```
C-----------------------------------------------------------------------
      SUBROUTINE RESTHR(T,IDIST,ANVP,DTSAMP,TOFLTM,TRATON,TPATON,TYATON,
     .                  DTACSA,DTACSB)
C-----------------------------------------------------------------------
C
C     SUBROUTINE NAME :      RESTHR
C
C     AUTHOR(S) :            T. THORNTON
C
C     FUNCTION  :            ATTITUDE CONTROL SYSTEM THRUSTER
C                            CROSS COUPLING LOGIC
C
C     CALLED FROM  :         FORTRAN MAIN
C
C     SUBROUTINES CALLED :   NONE
C
C     INPUTS :               T,IDIST,ANVP,DTSAMP,TOFLTM
C
C     OUTPUTS :              DTACSA,DTACSB
C
C     BOTH :                 TRATON,TPATON,TYATON
C
C     UPDATES :              B. HILL      - CR # 038
C                            T. THORNTON  - CR # 043
C                            T. THORNTON  - CR # 044
C                            B. HILL      - CR # 051
C                            D. SMITH     - CR # 059
C                            B. HILL /    - CR # 081
C                            R. RHYNE
C                            R. RHYNE     - CR # 084
C                            B. HILL      - CR # 086
C                            B. HILL      - CR # 093
C
C-----------------------------------------------------------------------

      IMPLICIT REAL (A-H)
      IMPLICIT REAL (O-Z)

      REAL  DTACSA(4)     , DTACSB(4)

* DATA INITIALIZATION
$INCLUDE('^/INCLUDE/SSDATA67.DAT')
$INCLUDE('^/INCLUDE/SSDATA03.DAT')
$INCLUDE('^/INCLUDE/SSDATA08.DAT')

C     IN DISTURBANCE MODE TURN OFF ACS THRUSTERS WITH DIVERT THRUSTERS

      IF( IDIST .EQ. 1 ) THEN
         TMP1 = TOFLTM - T
         IF( TMP1 .LE. 0. ) THEN
            TMP2 = 0.
         ELSEIF( TMP1 .LT. TSMPH ) THEN
            TMP2 = TMP1/TSMPH
         ELSE
            TMP2 = 1.
         ENDIF
         TPATON = TPATON*TMP2
         TYATON = TYATON*TMP2
         TRATON = TRATON*TMP2
      ENDIF
```

```
C     TEST SIGNS OF PITCH, YAW, ROLL AND ATTITUDE THRUSTER PULSEWIDTHS

C     PITCH SIGN TEST

      IF( TPATON .GE. 0.0 ) THEN
         TPATP = TPATON
         TPATN = 0.0
      ELSE
         TPATP = 0.0
         TPATN = -TPATON
      ENDIF

C     YAW SIGN TEST

      IF( TYATON .GE. 0.0 ) THEN
         TYATP = TYATON
         TYATN = 0.0
      ELSE
         TYATP = 0.0
         TYATN = -TYATON
      ENDIF

C     ROLL SIGN TEST

      IF( TRATON .GE. 0.0 ) THEN
         TRATP = TRATON
         TRATN = 0.0
      ELSE
         TRATP = 0.0
         TRATN = -TRATON
      ENDIF

C     RESOLVE PITCH, YAW, AND ROLL THRUSTER PULSEWIDTHS INTO
C     INDIVIDUAL THRUSTER PULSEWIDTHS

      IF( ANVP .LT. 1.5 ) THEN
         DTACSA(1) = TPATP + TRATP
         DTACSB(1) = TPATN + TRATN
         DTACSA(2) = TYATP
         DTACSB(2) = TYATN
         DTACSA(3) = TPATN + TRATP
         DTACSB(3) = TPATP + TRATN
         DTACSA(4) = TYATN
         DTACSB(4) = TYATP
      ELSE
         DTACSA(1) = TPATP + TRATP
         DTACSB(1) = TPATN + TRATN
         DTACSA(2) = TYATP + TRATP
         DTACSB(2) = TYATN + TRATN
         DTACSA(3) = TPATN + TRATP
         DTACSB(3) = TPATP + TRATN
         DTACSA(4) = TYATN + TRATP
         DTACSB(4) = TYATP + TRATN
      ENDIF

      DO 50 I=1,4

C        ENFORCE THRUSTER PAIR DEADBANDS

         IF( ABS( DTACSA(I) - DTACSB(I) ) .LT. ACSDB ) THEN
            DTACSA(I) = 0.0
            DTACSB(I) = 0.0
         ENDIF
```

```
C         ENFORCE MINIMUM COMMAND ON TIME

          IF((DTACSA(I) .LT. TCMINA .AND. DTACSA(I) .GT. 0.) .OR.
         .    (DTACSB(I) .LT. TCMINA .AND. DTACSB(I) .GT. 0.))  THEN
             DTACSA(I) = DTACSA(I) + TCMINA
             DTACSB(I) = DTACSB(I) + TCMINA
          ENDIF
          IF( DTACSA(I) .GT. DTSAMP ) DTACSA(I) = DTSAMP
          IF( DTACSB(I) .GT. DTSAMP ) DTACSB(I) = DTSAMP

   50   CONTINUE

        RETURN
        END
```

## B.2.35 Uurotmx.for

```
C-----------------------------------------------------------------------
      SUBROUTINE ROTMX(X,I,XM)
C-----------------------------------------------------------------------
C
C     SUBROUTINE NAME :      ROTMX
C
C     AUTHOR(S) :            J. SHEEHAN
C
C     FUNCTION  :            GENERATES A DIRECTION COSINE MATRIX
C
C     CALLED FROM  :         UTILITY SUBROUTINE
C
C     SUBROUTINES CALLED :   NONE
C
C     INPUTS :               X,I
C
C     OUTPUTS :              XM
C
C     UPDATES :              D. SMITH - CR # 59
C
C-----------------------------------------------------------------------
C
      IMPLICIT DOUBLE PRECISION (A-H)
      IMPLICIT DOUBLE PRECISION (O-Z)
      DOUBLE PRECISION XM(3,3)
C
      INTEGER IIT(3), IIIT(3)
      DATA IIT / 2 , 3  , 1  /
     .    ,IIIT/ 3 , 1  , 2  /
C
      SX = DSIN(X)
      CX = DCOS(X)
      II = IIT(I)
      III = IIIT(I)
C
      XM(I,I) = 1.0
      XM(I,II) = 0.0
      XM(I,III) = 0.0
      XM(II,I) = 0.0
      XM(III,I) = 0.0
C
      XM(II,II) = CX
      XM(III,III) = CX
      XM(II,III) = SX
      XM(III,II) = -SX
C
      RETURN
      END
```

## B.2.36 Uuseeker.for

```
C-----------------------------------------------------------------------
      SUBROUTINE SEEKER(T,ACQD,LAMSEK,MAGRTR,SKSEED,FRMRAT,FRMCNT,
     .                  SAMRAT,TRACK,TERM,SNR,LAMM)
C-----------------------------------------------------------------------
C
C     SUBROUTINE NAME :      SEEKER
C
C     AUTHOR(S) :            M. K. DOUBLEDAY, D. C. FOREMAN
C
C     FUNCTION  :            SEEKER MODEL
C
C     CALLED FROM  :         FORTRAN MAIN
C
C     SUBROUTINES CALLED :   NORM, TABLE
C
C     INPUTS :               T,ACQD,LAMSEK,MAGRTR
C
C     OUTPUTS :              SAMRAT,TRACK,TERM,SNR,LAMM
C
C     BOTH :                 SKSEED,FRMRAT,FRMCNT
C
C     UPDATES :              T. THORNTON - CR # 014
C                            B. HILL     - CR # 020
C                            D. SMITH    - CR # 027
C                            B. HILL     - CR # 030
C                            B. HILL     - CR # 038
C                            T. THORNTON - CR # 043
C                            T. THORNTON - CR # 044
C                            T. THORNTON - CR # 048
C                            D. SISSOM   - CR # 053
C                            D. SMITH    - CR # 059
C                            D. SMITH    - CR # 064
C                            D. SISSOM   - CR # 069
C                            D. SMITH    - CR # 074
C                            D. SMITH    - CR # 080
C                            B. HILL /   - CR # 081
C                            R. RHYNE
C                            D. SMITH    - CR # 082
C                            R. RHYNE    - CR # 084
C                            R. RHYNE    - CR # 087
C                            R. RHYNE    - CR # 088
C                            B. HILL     - CR # 093
C
C-----------------------------------------------------------------------

      IMPLICIT REAL          (A-H)
      IMPLICIT REAL          (O-Z)

      CHARACTER*128 MESSAGE
      REAL  ACQRNG(4,4)    , LAMB(2)        , LAMFOV
      REAL  LAMM(2)        , LAMNEA(2)      , LAMSEK(2)
      REAL  LAMSK(2)       , MAGRTR
      REAL  NEA            , RATE(6)        , SEKNOS(24)
      REAL  SEKTIM(24)     , TRGSIG(4)

      INTEGER           ACQD          , BCKGRD        , FRMCNT
      INTEGER           SEKTYP
      INTEGER*4         SKSEED
      INTEGER           TERM          , TRACK

C     LOCAL COMMON USED FOR CONSTANTS AND INITIALIZATION FLAG
```

```
      SAVE              ISEKR,    IFOV

* DATA INITIALIZATION
$INCLUDE('^/INCLUDE/SSDATA47.DAT')
$INCLUDE('^/INCLUDE/SSDATA48.DAT')
$INCLUDE('^/INCLUDE/SSDATA50.DAT')
$INCLUDE('^/INCLUDE/SSDATA55.DAT')
$INCLUDE('^/INCLUDE/SSDATA61.DAT')
$INCLUDE('^/INCLUDE/SSDATA68.DAT')
$INCLUDE('^/INCLUDE/SSDATA10.DAT')
$INCLUDE('^/INCLUDE/SSDATA11.DAT')

      DATA ISEKR / 1 /
      DATA IT / 1 /

      IF (ISEKR.EQ.1) THEN

         ISEKR = 0

         IF ( SEKTYP.EQ.2 ) THEN
            TSIG   = TRGSIG(ITRGSG)
            TSGACQ = TSIG
            RAQREF = ACQRNG(BCKGRD,ITRGSG)
            RNGAQ  = SQRT((TSGACQ/TSIG)*(6.0/SNRACQ)*
     .                                 (SQRT(1./FRMRAT)))*RAQREF
         ENDIF

      ENDIF

C     TEST FOR FIELD-OF-VIEW LIMIT

      IF ( SEKTYP.EQ.2 .AND. SNR.GE.SNRACQ ) THEN
         FOVCHK = FOVLIM
      ELSE IF ( ACQD.EQ.1 .AND. SEKTYP.NE.2 ) THEN
         FOVCHK = FOV
      ELSE
         FOVCHK = 1000.
      ENDIF
      LAMFOV = AMAX1( LAMSEK(1) , LAMSEK(2) )
      IF ( LAMFOV.GE.FOVCHK .AND. IFOV.EQ.0 ) THEN
         CALL OUTMES(' TRUE LOS ANGLE EXCEEDS FIELD-OF-VIEW LIMIT')
         IFOV   = 1
      ELSE IF ( LAMFOV.LE.FOVCHK .AND. IFOV.EQ.1 ) THEN
         CALL OUTMES(' TARGET REACQUIRED')
         IFOV   = 0
      ENDIF

C        DETERMINE SEEKER SAMPLE RATE FOR SEEKER TYPES 0 AND 1

      IF ( SEKTYP.EQ.0 .OR. SEKTYP.EQ.1 ) THEN
         IF ( MAGRTR .LE. RNGTRM ) THEN
            SAMRAT = SAMTRM
            IF (TERM.EQ.0) TERM = 1
         ELSE IF ( MAGRTR .LE. RNGTRK ) THEN
            SAMRAT = SAMTRK
            IF (TRACK.EQ.0) TRACK = 1
         ELSE
            SAMRAT = SAMACQ
         ENDIF
      ENDIF

C        PERFECT SEEKER MODEL
```

```
      IF ( SEKTYP.EQ.0 ) THEN
         LAMM(1) = LAMSEK(1)
         LAMM(2) = LAMSEK(2)
         FRMRAT  = 1.0/SAMRAT
      ENDIF

C     SEEKER MODEL DEPENDENT ON RANGE, FRAME, AND ENVIRONMENT

      IF ( SEKTYP.EQ.2 ) THEN

C        DETERMINE THE SIGNAL-TO-NOISE RATIO

         IF ( MAGRTR.LE.RFINAL ) THEN
            SNR = (RAQREF**2/RFINAL**2)*(TSGACQ/TSIG)*
     .            (SQRT(1.0/FRMRAT))*SNRACQ
         ELSE
            SNR = (RAQREF**2/MAGRTR**2)*(TSGACQ/TSIG)*
     .            (SQRT(1.0/FRMRAT))*SNRACQ
         ENDIF

C        CALCULATE THE NOISE EQUIVALENT ANGLE (RADIANS) FROM THE
C        EFFECTIVE SNR

         NEA    = (32.56*SNR**(-0.29912))*1.0E-6

C        MULTIPLY NOISE EQUIVALENT ANGLE BY NORMALLY DISTRIBUTED RANDOM
C        VARIABLE WITH A MEAN OF ZERO AND A STANDARD DEVIATION OF ONE

         CALL spNORM(1.0e0,0.0,SKSEED,RANA)
         CALL spNORM(1.0e0,0.0,SKSEED,RANB)

         LAMNEA(1) = NEA*RANA
         LAMNEA(2) = NEA*RANB

C        DETERMINE MEASURED LOS ANGLE (RADIANS)

         LAMB(1) = LAMSEK(1) + LAMNEA(1)
         LAMB(2) = LAMSEK(2) + LAMNEA(2)

C        QUANTIZE THE MEASURED LOS ANGLE (RADIANS)

         IF ( QNTZP.GT.0.0 ) THEN
            LAMM(1) = (AINT(LAMB(1)/QNTZP + 0.5))*QNTZP
            LAMM(2) = (AINT(LAMB(2)/QNTZP + 0.5))*QNTZP
         ELSE
            LAMM(1) = LAMB(1)
            LAMM(2) = LAMB(2)
         ENDIF

C        DETERMINE IF A FRAME RATE SWITCH IS REQUIRED

         IF ( MAGRTR.LE.RFINAL ) THEN
            FRMR = ((6.0/SNRMIN)*(TSGACQ/TSIG)*(RAQREF**2/RFINAL**2))**2
         ELSE
            FRMR = ((6.0/SNRMIN)*(TSGACQ/TSIG)*(RAQREF**2/MAGRTR**2))**2
         ENDIF

         IF ( FRMR.GE.RATE(FRMCNT) .AND. FRMCNT.LT.7 ) THEN
            FRMRAT = RATE(FRMCNT)
            FRMCNT = FRMCNT + 1
            WRITE(MESSAGE,101) T,FRMRAT
            CALL OUTMES(MESSAGE)
  101       FORMAT(1X,E16.9,' FRAME RATE CHANGE:  FRMRAT = ',E16.9)
         ENDIF
```

```
ENDIF

RETURN
END
```

## B.2.37 Uuspint.for

```
C-----------------------------------------------------------------------
      SUBROUTINE spINTEG ( X , XDOT , T , I )
C-----------------------------------------------------------------------
C
C     SUBROUTINE NAME :      INTEG
C
C     AUTHOR(S) :            D. F. SMITH
C
C     FUNCTION :             Perform simple trapezoidal integration of
C                            XDOT to yield X.  DTD is the time since
C                            the last integration and I is the array
C                            index where X is stored
C
C     CALLED FROM :          FORTRAN MAIN
C
C     SUBROUTINES CALLED :   NONE
C
C     INPUTS :               XDOT,T,I
C
C     OUTPUTS :              X
C
C     UPDATES :              D. SISSOM    - CR # 58
C                            D. SMITH     - CR # 59
C
C-----------------------------------------------------------------------
C
      COMMON/STORAG/     XINT,            TINT,            XDOTL
      REAL   XINT(50),       TINT(50),       XDOTL(50)
      REAL   DT,             DTMP,           X
      REAL   XDOT,           T

      DT       = T - TINT(I)

      XINT(I)  = XINT(I) + 0.5*DT*(XDOT+XDOTL(I))
      X        = XINT(I)

      TINT(I)  = T
      XDOTL(I) = XDOT

C     TEMPORARY CODE TO NORMALIZE QUATERNION AFTER 4TH COMPONENT IS
REVISED

      IF ( I.EQ.18 ) THEN
         DTMP   = SQRT ( XINT(15)**2 + XINT(16)**2 + XINT(17)**2 +
     .                   XINT(18)**2 )
         XINT(15) = XINT(15) / DTMP
         XINT(16) = XINT(16) / DTMP
         XINT(17) = XINT(17) / DTMP
         XINT(18) = XINT(18) / DTMP
      END IF

      RETURN
      END
```

## B.2.38 Uuspinti.for

```
C-----------------------------------------------------------------------
      SUBROUTINE spINTEGI ( X , XDOT , T , I )
C-----------------------------------------------------------------------
C
C     SUBROUTINE NAME :      INTEGI
C
C     AUTHOR(S) :            D. F. SMITH
C
C     FUNCTION :             Initialize integral of X which is stored
C                            in position I of the integral array
C
C     CALLED FROM :          MAIN
C
C     SUBROUTINES CALLED :   NONE
C
C     INPUTS :               X,XDOT,T,I
C
C     OUTPUTS :              NONE
C
C     UPDATES :              D. SISSOM    - CR # 58
C                            D. SMITH     - CR # 59
C
C-----------------------------------------------------------------------

      COMMON/STORAG/     XINT,            TINT,            XDOTL
      REAL   XINT(50),       TINT(50),        XDOTL(50)
      REAL   X,              T,               XDOT

      XINT(I)  = X
      XDOTL(I) = XDOT
      TINT(I)  = T

      RETURN
      END
```

## B.2.39 Uuspmmk.for

```
C-----------------------------------------------------------------------
      SUBROUTINE SPMMK(A,NA,B,NB,C,NC,RM)
C-----------------------------------------------------------------------
C
C     SUBROUTINE NAME :      MMK
C
C     AUTHOR(S) :            J. SHEEHAN
C
C     FUNCTION  :            GENERATES A DIRECTION COSINE MATRIX
C                            BY ROTATING IN ORDER:
C                              1) ANGLE C ABOUT THE NC AXIS
C                              2) ANGLE B ABOUT THE NB AXIS
C                              3) ANGLE A ABOUT THE NA AXIS
C
C     CALLED FROM  :         UTILITY SUBROUTINE
C
C     SUBROUTINES CALLED :   ROTMX, MMLXY
C
C     INPUTS :               A,NA,B,NB,C,NC
C
C     OUTPUTS :              RM
C
C     UPDATES :              D. SMITH    - CR # 59
C
C-----------------------------------------------------------------------
C
      IMPLICIT REAL (A-H)
      IMPLICIT REAL (O-Z)
C
      DIMENSION AM(3,3), BM(3,3), CM(3,3), RM(3,3), T(9)
C
      CALL SPROTMX(A,NA,AM)
      CALL SPROTMX(B,NB,BM)
      CALL SPROTMX(C,NC,CM)
C
      CALL SPMMLXY(BM,CM,T)
      CALL SPMMLXY(AM,T,RM)
C
      RETURN
      END
```

## B.2.40 Uuspmmlx.for

```
C-----------------------------------------------------------------------
      SUBROUTINE SPMMLXY(X,Y,Z)
C-----------------------------------------------------------------------
C
C     SUBROUTINE NAME :      MMLXY
C
C     AUTHOR(S) :            J. SHEEHAN
C
C     FUNCTION  :            MULTIPLY TWO 3X3 MATRICES
C
C     CALLED FROM  :         UTILITY SUBROUTINE
C
C     SUBROUTINES CALLED :   NONE
C
C     INPUTS :               X, Y
C
C     OUTPUTS :              Z
C
C     UPDATES :              D. SMITH    - CR # 59
C
C-----------------------------------------------------------------------
C
      IMPLICIT REAL (A-H)
      IMPLICIT REAL (O-Z)
C
      DIMENSION X(3,3), Y(3,3), Z(3,3)
C
C     Z(I,J) = X(I,1)*Y(1,J) + X(I,2)*Y(2,J) + X(I,3)*Y(3,J)
C
      Z(1,1) = X(1,1)*Y(1,1) + X(1,2)*Y(2,1) + X(1,3)*Y(3,1)
      Z(2,1) = X(2,1)*Y(1,1) + X(2,2)*Y(2,1) + X(2,3)*Y(3,1)
      Z(3,1) = X(3,1)*Y(1,1) + X(3,2)*Y(2,1) + X(3,3)*Y(3,1)
      Z(1,2) = X(1,1)*Y(1,2) + X(1,2)*Y(2,2) + X(1,3)*Y(3,2)
      Z(2,2) = X(2,1)*Y(1,2) + X(2,2)*Y(2,2) + X(2,3)*Y(3,2)
      Z(3,2) = X(3,1)*Y(1,2) + X(3,2)*Y(2,2) + X(3,3)*Y(3,2)
      Z(1,3) = X(1,1)*Y(1,3) + X(1,2)*Y(2,3) + X(1,3)*Y(3,3)
      Z(2,3) = X(2,1)*Y(1,3) + X(2,2)*Y(2,3) + X(2,3)*Y(3,3)
      Z(3,3) = X(3,1)*Y(1,3) + X(3,2)*Y(2,3) + X(3,3)*Y(3,3)
C
      RETURN
      END
```

## B.2.41 Uuspran.for

```
C-----------------------------------------------------------------------
      REAL FUNCTION RAN(ISEED)
C-----------------------------------------------------------------------
C
C     SUBROUTINE NAME :      RAN
C
C     AUTHOR(S) :            D. F. SMITH
C
C     FUNCTION :             GENERATES A UNIFORMLY DISTRIBUTED RANDOM
C                            NUMBER
C
C     CALLED FROM :          UTILITY SUBROUTINE
C
C     SUBROUTINES CALLED :   NONE
C
C     INPUTS :               NONE
C
C     OUTPUTS :              RAN
C
C     BOTH :                 ISEED
C
C     UPDATES :              NONE
C
C-----------------------------------------------------------------------
      integer*4 iseed

      iseed = 69069*iseed + 1
      ran = abs(float(iseed)/2147483647.0)
      RETURN
      END
```

## B.2.42 Uuspran0.for

```
C-----------------------------------------------------------------------
       REAL FUNCTION spRAN0(ISEED)
C-----------------------------------------------------------------------
C
C      SUBROUTINE NAME :      RAN0
C
C      AUTHOR(S) :            D. F. SMITH
C
C      FUNCTION :             GENERATES A UNIFORMLY DISTRIBUTED RANDOM
C                             NUMBER BETWEEN 0 AND 1 USING THE SYSTEM
C                             ROUTINE RAN(ISEED) . THE BUFFER IN COMMON
C                             BLOCK RANCOM IS INITIALIZED BY CALLING
C                             ROUTINE RANIT .
C
C      CALLED FROM :          UTILITY SUBROUTINE
C
C      SUBROUTINES CALLED :   RAN
C
C      INPUTS :               NONE
C
C      OUTPUTS :              RAN0
C
C      BOTH :                 ISEED
C
C      UPDATES :              NONE
C
C-----------------------------------------------------------------------
C
      integer*4 iseed
      COMMON / RANCOM /          RANSEQ(97),      RANLST

C     USE PREVIOUSLY SAVED RANDOM NUMBER AS BUFFER INDEX AND MAKE
C     SURE ARRAY BOUNDS ARE NOT EXCEEDED .


      J       = 1 + INT ( 97.0*RANLST )
      IF ( J.LT.1 .OR. J.GT.97 ) THEN
         CALL OUTMES(' RANDOM NUMBER OUT OF BOUNDS IN RAN0')
      END IF

C     RETRIEVE RANDOM NUMBER FROM BUFFER FOR OUTPUT AND SAVE IT FOR
C     USE AS AN INDEX ON THE NEXT PASS .

      RANLST = RANSEQ(J)
      SPRAN0   = RANLST

C     LOAD A NEW RANDOM NUMBER IN THE SLOT JUST VACATED .

      RANSEQ(J, = RAN ( ISEED )

      RETURN
      END
```

## B.2.43 Uusprotm.for

```
C-----------------------------------------------------------------------
      SUBROUTINE SPROTMX(X,I,XM)
C-----------------------------------------------------------------------
C
C     SUBROUTINE NAME :      ROTMX
C
C     AUTHOR(S) :            J. SHEEHAN
C
C     FUNCTION  :            GENERATES A DIRECTION COSINE MATRIX
C
C     CALLED FROM  :         UTILITY SUBROUTINE
C
C     SUBROUTINES CALLED :   NONE
C
C     INPUTS :               X,I
C
C     OUTPUTS :              XM
C
C     UPDATES :              D. SMITH - CR # 59
C
C-----------------------------------------------------------------------
C
      IMPLICIT REAL (A-H)
      IMPLICIT REAL (O-Z)
      REAL XM(3,3)
C
      INTEGER IIT(3), IIIT(3)
      DATA IIT / 2 , 3  , 1  /
     .    ,IIIT/ 3 , 1  , 2  /
C
      SX = SIN(X)
      CX = COS(X)
      II = IIT(I)
      III = IIIT(I)
C
      XM(I,I) = 1.0
      XM(I,II) = 0.0
      XM(I,III) = 0.0
      XM(II,I) = 0.0
      XM(III,I) = 0.0
C
      XM(II,II) = CX
      XM(III,III) = CX
      XM(II,III) = SX
      XM(III,II) = -SX
C
      RETURN
      END
```

## B.2.44 Uutable.for

```
C-----------------------------------------------------------------------
      SUBROUTINE spTABLE(XTAB,YTAB,X,Y,N,I)
C-----------------------------------------------------------------------
C
C      SUBROUTINE NAME :      TABLE
C
C      AUTHOR(S) :            D. SMITH
C
C      FUNCTION :             PERFORMS TABLE LOOKUP VIA EITHER INDEXED
C                             SEARCH OR BINARY SEARCH AND LINEARLY
C                             INTERPOLATES
C
C      CALLED FROM :          UTILITY SUBROUTINE
C
C      SUBROUTINES CALLED :   NONE
C
C      INPUTS :               XTAB,YTAB,X,N
C
C      OUTPUTS :              Y
C
C      BOTH :                 I
C
C      UPDATES :              D. SMITH    - CR # 27
C                             B. HILL     - CR # 38
C                             B. HILL     - CR # 46
C                             D. SMITH    - CR # 59
C
C-----------------------------------------------------------------------
C
      IMPLICIT real (A-H)
      IMPLICIT real (O-Z)
      INTEGER N,I
      real XTAB(N),YTAB(N)
C
      IF ( I.GE.1 .AND. I.LE.N ) THEN
         IF ( X.LE.XTAB(1) ) THEN
            Y      = YTAB(1)
            I      = 1
         ELSE IF ( X.GE.XTAB(N) ) THEN
            Y      = YTAB(N)
            I      = N
         ELSE IF ( X.GE.XTAB(I) ) THEN
            DO 10 K = I , N-1
               IF ( X.LT.XTAB(K+1) ) GO TO 20
   10       CONTINUE
   20       FRACT  = ( X - XTAB(K) ) / ( XTAB(K+1) - XTAB(K) )
            Y      = YTAB(K) + FRACT * ( YTAB(K+1) - YTAB(K) )
            I      = K
         ELSE IF ( X.LT.XTAB(I) ) THEN
            DO 30 K = I-1 , 1 , -1
               IF ( X.GE.XTAB(K) ) GO TO 40
   30       CONTINUE
   40       FRACT  = ( X - XTAB(K) ) / ( XTAB(K+1) - XTAB(K) )
            Y      = YTAB(K) + FRACT * ( YTAB(K+1) - YTAB(K) )
            I      = K
         END IF
C
C     PERFORM BINARY SEARCH IF POINTER IS ZERO OR OUT OF BOUNDS
C
      ELSE IF ( I.LT.1 .OR. I.GT.N ) THEN
         IF ( X.GT.XTAB(1) .AND. X.LT.XTAB(N) ) THEN
```

```
            K       = 1
            L       = N
            DO 50 I = K , L
               IF ( L.EQ.K+1 ) GO TO 60
               M       = ( K + L ) / 2
               IF ( X.LT.XTAB(M) ) THEN
                  L       = M
               ELSE
                  K       = M
               END IF
50          CONTINUE
60          FRACT  = ( X - XTAB(K) ) / ( XTAB(L) - XTAB(K) )
            Y      = YTAB(K) + FRACT * ( YTAB(L) - YTAB(K) )
            I      = K
         ELSE IF ( X.LE.XTAB(1) ) THEN
            Y      = YTAB(1)
            I      = 1
         ELSE IF ( X.GE.XTAB(N) ) THEN
            Y      = YTAB(N)
            I      = N
         END IF
      END IF
C
      RETURN
      END
```

## B.2.45 Uuvcsth2.for

```
C-----------------------------------------------------------------------
      SUBROUTINE VCSTHR2(T,FLTC,FLTCP,FLTCY,TBURNM,TOFFLT,
     .                   TIMONV,IVTAB)
C-----------------------------------------------------------------------
C
C     SUBROUTINE NAME :      VCSTHR2
C
C     AUTHOR(S) :            B. HILL
C
C     FUNCTION  :            RESOLVES THE VCS THRUSTER BURN TIMES INTO
C                            THEIR APPROPRIATE FORCES AND MOMENTS
C
C     CALLED FROM  :         FORTRAN MAIN
C
C     INPUTS :               T,TOFFLT,TIMONV
C
C     OUTPUTS :              FLTCP,FLTCY
C
C     BOTH :                 TBURNM,FLTC,IVTAB
C
C     UPDATES :              D. SISSOM   - CR # 017
C                            B. HILL     - CR # 030
C                            D. SISSOM   - CR # 032
C                            B. HILL     - CR # 038
C                            T. THORNTON - CR # 043
C                            B. HILL     - CR # 051
C                            B. HILL     - CR # 057
C                            D. SMITH    - CR # 059
C                            D. SISSOM   - CR # 069
C                            D. SMITH    - CR # 074
C                            D. SMITH    - CR # 076
C                            D. SMITH    - CR # 080
C                            B. HILL /   - CR # 081
C                            R. RHYNE
C                            D. SMITH    - CR # 082
C                            R. RHYNE    - CR # 084
C                            B. HILL     - CR # 086
C                            R. RHYNE    - CR # 087
C                            B. HILL     - CR # 089
C                            B. HILL     - CR # 093
C
C-----------------------------------------------------------------------

      IMPLICIT REAL          (A-H)
      IMPLICIT REAL          (O-Z)

      REAL  FLTC(4)        , TOFFLT(4)

* DATA INITIALIZATION
$INCLUDE('^/INCLUDE/SSDATA09.DAT')

      IF (IVTAB .EQ. 1) THEN

         ivtab  = 0

         IF ( TBURNM .GE. TCMINV ) THEN

            TBURNM = 0.0

         ENDIF
      ENDIF
```

```
      DO 30 I=1,4
         IF ( (TOFFLT(I)-T).LE.0.0 )  FLTC(I) = 0.0
30    CONTINUE

      IF ( FLTC(1).EQ.0.0 .AND. FLTC(3).EQ.0.0 .AND.
     .     (TIMONV).LE.T ) FLTCY = 0.0
      IF ( FLTC(2).EQ.0.0 .AND. FLTC(4).EQ.0.0 .AND.
     .     (TIMONV).LE.T ) FLTCP = 0.0

      END
```

## B.2.46 Uuvcsthr.for

```
C-----------------------------------------------------------------------
      SUBROUTINE VCSTHR(T,CG,TBURNM,IVCS,TOFFLT,
     .                  TIMONV,DTOFFV,TVTAB,FOFF1,FOFF2,IVTAB,TBRK,
     .                  FXVCS,FYVCS,FZVCS,MXVCS,MYVCS,MZVCS,MDOTV)
C-----------------------------------------------------------------------
C
C     SUBROUTINE NAME :      VCSTHR
C
C     AUTHOR(S) :            B. HILL
C
C     FUNCTION  :            RESOLVES THE VCS THRUSTER BURN TIMES INTO
C                            THEIR APPROPRIATE FORCES AND MOMENTS
C
C     CALLED FROM  :         FORTRAN MAIN
C
C     SUBROUTINES CALLED :   TABLE
C
C     INPUTS :               T,CG,TBURNM,IVCS,
C                            TOFFLT,TIMONV,DTOFFV,TVTAB,FOFF1,FOFF2,IVTAB
C
C     OUTPUTS :              FXVCS,FYVCS,FZVCS,MXVCS,MYVCS,
C                            MZVCS,MDOTV
C
C     BOTH :                 TBRK
C
C     UPDATES :              D. SISSOM    - CR # 017
C                            B. HILL      - CR # 030
C                            D. SISSOM    - CR # 032
C                            B. HILL      - CR # 038
C                            T. THORNTON  - CR # 043
C                            B. HILL      - CR # 051
C                            B. HILL      - CR # 057
C                            D. SMITH     - CR # 059
C                            D. SISSOM    - CR # 069
C                            D. SMITH     - CR # 074
C                            D. SMITH     - CR # 076
C                            D. SMITH     - CR # 080
C                            B. HILL /    - CR # 081
C                            R. RHYNE
C                            D. SMITH     - CR # 082
C                            R. RHYNE     - CR # 084
C                            B. HILL      - CR # 086
C                            R. RHYNE     - CR # 087
C                            B. HILL      - CR # 089
C                            B. HILL      - CR # 093
C
C-----------------------------------------------------------------------

      IMPLICIT REAL          (A-H)
      IMPLICIT REAL          (O-Z)

      REAL  ATHRV(4)       , CG(3)          , DTOFFV(4)
      REAL  F(3)           , F0(3)
      REAL  FOFF1(4)       , FOFF2(4)       , ISPVCS
      REAL  M(3)           , MDOTV          , MXVCS
      REAL  MYVCS          , MZVCS          , THVCS(6,4)
      REAL  TMVCS(6,4)     , TOFFLT(4)
      REAL  VCSDIR(3,4)    , VCSLOC(3,4)    , VCSMA(9,4)
      REAL  VOFF1(4)       , VOFF2(4)       , XMOT(3)

      INTEGER           INDX(4)
```

```
      INTEGER           LENVCS(4)

C     LOCAL COMMON USED FOR CONSTANTS,LOCAL VARIABLES AND
C     INITIALIZATION FLAG

      SAVE              IVCSTH , VCSMA

C     COMMON "RVCSTR" USED FOR MIDFLIGHT CAPABILITIES ONLY

      COMMON / RVCSTR / TREFLV , TLSTV  , TMVCS  , THVCS  , LENVCS

* DATA INITIALIZATION
$INCLUDE('^/INCLUDE/SSDATA70.DAT')
$INCLUDE('^/INCLUDE/SSDATA09.DAT')

      DATA IVCSTH / 1 /

      IF (IVCSTH.EQ.1) THEN

         IVCSTH = 0

C        VCS MISALIGNMENT DIRECTIONS
C        VOFF1 = CONE ANGLE OFF NORMAL
C        VOFF2 = POLAR ANGLE

         DO 10 I = 1,4
            VOFF1(I) = FOFF1(I)
            VOFF2(I) = FOFF2(I)
10       CONTINUE

C        VCS THRUSTER MISALIGNMENT MATRIX

         DO 200 I = 1 , 4
            CVOFF1 = COS(VOFF1(I))
            SVOFF1 = SIN(VOFF1(I))
            CVOFF2 = COS(VOFF2(I))
            SVOFF2 = SIN(VOFF2(I))
            VCSMA(1,I) = CVOFF1
            VCSMA(2,I) = SVOFF1*CVOFF2
            VCSMA(3,I) = SVOFF1*SVOFF2
            VCSMA(4,I) = SVOFF1*SVOFF2
            VCSMA(5,I) = CVOFF1
            VCSMA(6,I) = SVOFF1*CVOFF2
            VCSMA(7,I) = SVOFF1*CVOFF2
            VCSMA(8,I) = SVOFF1*SVOFF2
            VCSMA(9,I) = CVOFF1
  200    CONTINUE
      ENDIF

C     RESET THE FORCE AND MOMENT TO ZERO

      FXVCS  = 0.0
      FYVCS  = 0.0
      FZVCS  = 0.0
      MXVCS  = 0.0
      MYVCS  = 0.0
      MZVCS  = 0.0
      MDOTV  = 0.0

      IF (IVTAB .EQ. 1) THEN

         IF ( TBURNM .GE. TCMINV ) THEN

C           DEFINE VCS THRUST PROFILE
```

```
            TMVCS(1,IVCS)  = TVTAB
            THVCS(1,IVCS)  = 0.0
            TMVCS(2,IVCS)  = TIMONV
            THVCS(2,IVCS)  = 0.0
            TMVCS(3,IVCS)  = TIMONV + TRUPV
            THVCS(3,IVCS)  = FLATM
            TMVCS(4,IVCS)  = TIMONV + TBURNM
            THVCS(4,IVCS)  = FLATM
            TMVCS(5,IVCS)  = TMVCS(4,IVCS) + TRDNV
            THVCS(5,IVCS)  = 0.0
            TMVCS(6,IVCS)  = 999.0
            THVCS(6,IVCS)  = 0.0
            LENVCS(IVCS)   = 6

         ENDIF

C           GENERATE THRUSTER RESPONSE CURVE

         DO 15 I=1,4
            IF ( DTOFFV(I).GT.0.0 ) THEN
               TMVCS(1,I) = TVTAB
               THVCS(1,I) = 0.0
               TMVCS(2,I) = TVTAB + TLAGV
               THVCS(2,I) = 0.0
               TMVCS(3,I) = TMVCS(2,I) + TRUPV
               THVCS(3,I) = FLATM
               TMVCS(4,I) = TOFFLT(I)
               THVCS(4,I) = FLATM
               TMVCS(5,I) = TMVCS(4,I) + TRDNV
               THVCS(5,I) = 0.0
               TMVCS(6,I) = 999.0
               THVCS(6,I) = 0.0
               LENVCS(I)  = 6
            ENDIF
15       CONTINUE
      ENDIF

C     SET TABLE LOOKUP REFERENCE TIME

      TREF   = T

      DO 20 I=1,4

C        COMPUTE INSTANTANEOUS THRUST LEVEL VIA TABLE LOOKUP IF VCS
C        CYCLE IS SCHEDULED FOR THIS THRUSTER . ALSO EXTRAPOLATE TIME
C        OF NEXT VCS TABLE LOOKUP INDEX TRANSITION .

         IF ( TMVCS(1,I).GT.0.0 ) THEN
            CALL spTABLE(TMVCS(1,I),THVCS(1,I),TREF,ATHRV(I),
     .                   LENVCS(I),INDX(I))
         ELSE
            ATHRV(I) = 0.0
            INDX(I)  = 0
         ENDIF

C        CALCULATE FORCES AND MOMENTS DUE TO THE VCS THRUSTERS :
C             F(I) IS THE FORCE ALONG THE Ith AXIS.
C             XMOT(I) IS THE EFFECTIVE MOMENT ARM.
C             FORCES ARE ADJUSTED FOR MISALIGNMENT EFFECTS.
C             THE MOMENT GENERATED IS ( F x XMOT).

         DO 25 J=1,3
            F0(J)    = VCSDIR(J,I)*ATHRV(I)
```

```
            XMOT(J) = CG(J) - VCSLOC(J,I)
25        CONTINUE

          F(1)    = VCSMA(1,I)*F0(1) +VCSMA(4,I)*F0(2) +VCSMA(7,I)*F0(3)
          F(2)    = VCSMA(2,I)*F0(1) +VCSMA(5,I)*F0(2) +VCSMA(8,I)*F0(3)
          F(3)    = VCSMA(3,I)*F0(1) +VCSMA(6,I)*F0(2) +VCSMA(9,I)*F0(3)

          M(1)    = F(2)*XMOT(3) - F(3)*XMOT(2)
          M(2)    = F(3)*XMOT(1) - F(1)*XMOT(3)
          M(3)    = F(1)*XMOT(2) - F(2)*XMOT(1)

          FXVCS   = FXVCS + F(1)
          FYVCS   = FYVCS + F(2)
          FZVCS   = FZVCS + F(3)
          MXVCS   = MXVCS + M(1)
          MYVCS   = MYVCS + M(2)
          MZVCS   = MZVCS + M(3)

          MDOTV   = MDOTV + ATHRV(I)/ISPVCS
20      CONTINUE

        END
```

## B.3 Mainlines (C)

### B.3.1 Uup00.c

```
/* uup00.f -- translated by f2c (version of 3 February 1990  3:36:42).
   You must link the resulting object file with the libraries:
      -lF77 -lI77 -lm -lc   (in that order)
*/

#include "f2c.h"

/* Common Block Declarations */

struct {
    real xint[50], tint[50], xdotl[50];
} storag_;

#define storag_1 storag_

struct {
    real tlstm, massl;
} rmass_;

#define rmass_1 rmass_

struct {
    real xyzlch[3];
} rmissl_;

#define rmissl_1 rmissl_

/* Table of constant values */

static shortint cs__1 = 1;
static shortint cs__5 = 5;
static shortint cs__12 = 12;
static shortint cs__13 = 13;
static shortint cs__14 = 14;
static shortint cs__15 = 15;
static shortint cs__16 = 16;
static shortint cs__17 = 17;
static shortint cs__18 = 18;
static integer c__1 = 1;
static real c_b14 = (float)0.;
static shortint cs__2 = 2;
static shortint cs__3 = 3;

/*      PROGRAM EXOSIM */
/* ----------------------------------------------------------------------
-C */
/* --------------- Declare and initialize variables  ------------------
-C */
/* ----------------------------------------------------------------------
-C */
/* Main program */ MAIN__()
{
    /* Format strings */
    static char fmt_155[] = "(1x,e16.9,\002 DROP NOSE FAIRING AND BOOST
ADAP\
TER\002)";

    /* System generated locals */
```

```
    real r_1;

    /* Builtin functions */
    integer s_wsfi(), do_fio(), e_wsfi();

    /* Local variables */
    static real delt;
    static shortint igit;
    static real eisp, mass, mdot, quat[4];
    extern /* Subroutine */ int spintegi_();
    static real tmsudriv, tmsustep, p, q, r, t, u, v, w, wbanf, mdota,
mxacs,
        myacs, mzacs, quatd[4];
    static shortint imass, idrop;
    static real dteps;
    static shortint iexit;
    static real tdrop, mdotv, xmtof, tstep, mxvcs, myvcs, mzvcs, tlmsu;
    extern /* Subroutine */ int receive_real_32bit__();
    static real wprop, pd, qd, rd, xd, yd, zd;
    static shortint nclear;
    static real mx, my, mz, tfinal, weight;
    extern /* Subroutine */ int send_real_32bit__(), masspr_();
    static real impuls, wdotti;
    extern /* Subroutine */ int outmes_();
    static real wdotkv, wdottp;
    extern /* Subroutine */ int missil2_();
    static real cim[9], phi;
    extern /* Subroutine */ int cw87_();
    static real psi, tht;
    static char message[128];
    static real wkv, ixx, iyy, izz;
    extern /* Subroutine */ int spinteg_(), receive_signed_16bit__();

    /* Fortran I/O blocks */
    static icilist io__55 = { 0, message, 0, fmt_155, 128, 1 };


/*     THE FOLLOWING COMMON BLOCKS USED FOR MIDFLIGHT CAPABILITIES ONLY
*/

/*     OUTPUTS */
/*     NAMELIST INPUTS */
/* DATA INITIALIZATION */
/* $INCLUDE('^/INCLUDE/SSDATA35.DAT') */
/* $INCLUDE('^/INCLUDE/SSDATA38.DAT') */
/* $INCLUDE('^/INCLUDE/SSDATA39.DAT') */
/* $INCLUDE('^/INCLUDE/SSDATA42.DAT') */
/* $INCLUDE('^/INCLUDE/SSDATA44.DAT') */
/* $INCLUDE('^/INCLUDE/SSDATA45.DAT') */
/* $INCLUDE('^/INCLUDE/SSDATA46.DAT') */
/* $INCLUDE('^/INCLUDE/SSDATA47.DAT') */
/* $INCLUDE('^/INCLUDE/SSDATA48.DAT') */
/* $INCLUDE('^/INCLUDE/SSDATA49.DAT') */
/* $INCLUDE('^/INCLUDE/SSDATA50.DAT') */
/* $INCLUDE('^/INCLUDE/SSDATA01.DAT') */
/* $INCLUDE('^/INCLUDE/SSDATA17.DAT') */
/* $INCLUDE('^/INCLUDE/SSDATA18.DAT') */
/* $INCLUDE('^/INCLUDE/SSDATA21.DAT') */
/* $INCLUDE('^/INCLUDE/SSDATA22.DAT') */
/* $INCLUDE('^/INCLUDE/SSDATA23.DAT') */
/* $INCLUDE('^/INCLUDE/SSDATA28.DAT') */
/* $INCLUDE('^/INCLUDE/SSDATA29.DAT') */
/* $INCLUDE('^/INCLUDE/SSDATA30.DAT') */
/* $INCLUDE('^/INCLUDE/SSDATA71.DAT') */
```

```
/* $INCLUDE('^/INCLUDE/SSTIMING.DAT') */
/* $INCLUDE('SSp00.DAT') */
/* INITIALIZE 80x87 */
    cw87_();
/*
-----------------------------------------------------------------
-----C */
/* ----------------------------- MAIN EXECUTION LOOP
--------------------C */
/*
-----------------------------------------------------------------
-----C */
/*                                Execution of all events is performed
C
*/
/*                                within this loop
C
*/
/*
C
*/
/*
-----------------------------------------------------------------
-----C */
/*     call initialize_timing() */
L1000:
/*     call start_timing(0) */
/*     WRITE(*,*)'--------------BEGINNING OF LOOP-----------------' */
/*
-----------------------------------------------------------------
-----C */
/* --------------------------- MISSILE STATE UPDATE MODULE
--------------C */
/*
-----------------------------------------------------------------
-----C */
/*                              Integrate missile states to current time
C
*/
/*
C
*/
/*
-----------------------------------------------------------------
-----C */
/* 1001     format(1x,f7.4,3(a,1pe13.6)) */
/* 1002     format(1x,3(a,1pe13.6)) */
/*      write(message,1001)t,'p ',p,' q ',q,' r ',r */
/*      call outmes(message) */
/*      write(message,1002)'       pd ',pd,' qd ',qd,' rd ',rd */
/*      call outmes(message) */
/*      write(message,1002)'   cim(1) ',cim(1),' (2) ',cim(2), */
/*     *                                ' (3) ',cim(3) */
/*      call outmes(message) */
/*      write(message,1002)'      (4) ',cim(4),' (5) ',cim(5), */
/*     *                                ' (6) ',cim(6) */
/*      call outmes(message) */
/*      write(message,1002)'      (7) ',cim(7),' (8) ',cim(8), */
/*     *                                ' (9) ',cim(9) */
/*      call outmes(message) */
    if (tstep >= tmsudriv) {
      tmsudriv += tmsustep;
/*
-----------------------------------------------------------------
```

```
---------C */
/* ---------------------------- MASS PROPERTIES MODULE
------------------C */
/*
-------------------------------------------------------------
---------C */
/*                              Update mass flow rate, cg and inertia
  C */
/*
  C */
/*
-------------------------------------------------------------
---------C */
      masspr_(&t, &mdota, &mdotv, &mass, &eisp, &imass, &mdot, &weight,
&
            wdottp, &wdotkv, &wdotti, &ixx, &iyy, &izz);
/*
-------------------------------------------------------------
---------C */
/* ---------------------------- VEHICLE STATES MODULE
------------------C */
/*
-------------------------------------------------------------
---------C */
/*                               Compute missile state derivatives
  C */
/*
  C */
/*
-------------------------------------------------------------
---------C */
      missil2_(&t, quat, cim, &p, &q, &r, &ixx, &iyy, &izz, &mxacs,
&mxvcs,
            &myacs, &myvcs, &mzacs, &mzvcs, &xd, &yd, &zd, &nclear, &pd,
&
            qd, &rd, &mx, &my, &mz, &u, &v, &w, quatd, &phi, &tht,
&psi);
/*
-------------------------------------------------------------
---------C */
/*                               MISSILE STATE INTEGRATION MODULE
  C */
/*
-------------------------------------------------------------
---------C */
/*                               Revise missile states using
derivatives C */
/*                               just computed . Missile states must
not C */
/*                               be integrated if a table lookup index
  C */
/*                               transition has occurred since the
last  C */
/*                               integration step . The next
integration C */
/*                               step should be rescheduled to
coincide  C */
/*                               with the earliest detected table
lookup C */
/*                               index transition instead . Otherwise
  C */
/*                               schedule the next integration step to
  C */
/*                               occur at the default step size .
```

```
  C */
/*
  C */
/*
-------------------------------------------------------------
---------C */
/*        TRAPEZOIDAL INTEGRATION FOR SIMPLICITY */
      spinteg_(&mass, &mdot, &t, &cs__1);
      spinteg_(&wkv, &wdotkv, &t, &cs__5);
      spinteg_(&p, &pd, &t, &cs__12);
      spinteg_(&q, &qd, &t, &cs__13);
      spinteg_(&r, &rd, &t, &cs__14);
      spinteg_(quat, quatd, &t, &cs__15);
      spinteg_(&quat[1], &quatd[1], &t, &cs__16);
      spinteg_(&quat[2], &quatd[2], &t, &cs__17);
      spinteg_(&quat[3], &quatd[3], &t, &cs__18);
/*        SAVE TIME OF LAST MISSILE STATE UPDATE */
      tlmsu = t;
    }
/*
-----------------------------------------------------------------
-----C */
/* ----------------------------- SEPARATION MODULE
----------------------C */
/*
-----------------------------------------------------------------
-----C */
/*                                Models discontinuities occuring during
C
*/
/*                                stage separation
C
*/
/*
C
*/
/*
-----------------------------------------------------------------
-----C */
/*        NOSE FAIRING / BOOST ADAPTER SEPARATION */
    if (idrop == 1 || (r_1 = t - tdrop, dabs(r_1)) <= dteps && igit ==
1) {
      wkv -= wbanf;
      mass = wkv / xmtof;
      s_wsfi(&io__55);
      do_fio(&c__1, (char *)&t, (ftnlen)sizeof(real));
      e_wsfi();
      outmes_(message, 128L);
/*           REINITIALIZE PERTINENT INTEGRALS */
      spintegi_(&mass, &c_b14, &t, &cs__1);
      spintegi_(&wprop, &c_b14, &t, &cs__2);
      spintegi_(&impuls, &c_b14, &t, &cs__3);
      spintegi_(&wkv, &c_b14, &t, &cs__5);
    }
/*
-----------------------------------------------------------------
-----C */
/* ----------------------- Processor communication
----------------------C */
/*
-----------------------------------------------------------------
-----C */
/*     call switch_timing() */
/* ---------  Communicate with p01  -----------C */
```

```
    send_real_32bit__(&ixx);
    send_real_32bit__(&iyy);
    send_real_32bit__(&izz);
    send_real_32bit__(&mass);
/* -------------  Communicate with p03 -------------------------------C
*/
    send_real_32bit__(&p);
    send_real_32bit__(&q);
    send_real_32bit__(&r);
/*     CALL RECEIVE_REAL_64BIT( d_XD ) */
/*     XD = d_XD */
/*     CALL RECEIVE_REAL_64BIT( d_YD ) */
/*     YD = d_YD */
/*     CALL RECEIVE_REAL_64BIT( d_ZD ) */
/*     ZD = d_ZD */
    receive_real_32bit__(&xd);
    receive_real_32bit__(&yd);
    receive_real_32bit__(&zd);
    send_real_32bit__(cim);
    send_real_32bit__(&cim[1]);
    send_real_32bit__(&cim[2]);
    send_real_32bit__(&cim[3]);
    send_real_32bit__(&cim[4]);
    send_real_32bit__(&cim[5]);
    send_real_32bit__(&cim[6]);
    send_real_32bit__(&cim[7]);
    send_real_32bit__(&cim[8]);
/* ---------  Communicate with p01  -----------C */
    receive_signed_16bit__(&idrop);
/* ---------  Receive from ACSTHR and VCSTHR  -----------C */
    receive_real_32bit__(&mdotv);
    receive_real_32bit__(&mdota);
    receive_real_32bit__(&mxvcs);
    receive_real_32bit__(&myvcs);
    receive_real_32bit__(&mzvcs);
    receive_real_32bit__(&mxacs);
    receive_real_32bit__(&myacs);
    receive_real_32bit__(&mzacs);
    send_real_32bit__(&pd);
    send_real_32bit__(&qd);
    send_real_32bit__(&rd);
/*     call switch_timing() */
/*
-------------------------------------------------------------------
-----C */
/* ----------------------------- OUTPUT MODULE
-------------------------C */
/*
-------------------------------------------------------------------
-----C */
/*                                Creates print and plot output data
C
*/
/*                                files
C
*/
/*
C
*/
/*
-------------------------------------------------------------------
-----C */
/*     call stop_timing() */
/*     if (  mod(int(tstep),int(dtprt)).eq.0 ) then */
```

```
/*        call output_timing() */
/*        call initialize_timing() */
/*     ENDIF */
/*
-------------------------------------------------------------------
-----C */
/* ----------------------------- TERMINATION LOGIC
----------------------C */
/*
-------------------------------------------------------------------
-----C */
/*                                Defines the simulation termination
C
*/
/*                                conditions
C
*/
/*
C
*/
/*
-------------------------------------------------------------------
-----C */
/*     INITIALIZE SIMULATION EXIT FLAG TO ZERO ( PREVENTS EXIT ) */
    iexit = 0;
/*     ENABLE EXIT IF MAXIMUM SIMULATION TIME HAS BEEN EXECUTED AND ALL
*/

/*     EVENTS SCHEDULED FOR THIS TIME HAVE BEEN EXECUTED */
    if (t >= tfinal) {
      iexit = 1;
    }
/*     increment time */
    tstep += (float)1.;
    t = tstep * delt;
/*     CONTINUE LOOPING UNTIL ONE OR MORE EXIT CONDITIONS HAVE BEEN MET
*/

    if (iexit == 0) {
      goto L1000;
    }
    outmes_("ERROR: Exit from P00", 20L);
} /* MAIN__ */
```

## B.3.2 Uup01.c

```
/* uup01.f -- translated by f2c (version of 3 February 1990  3:36:42).
   You must link the resulting object file with the libraries:
      -lF77 -lI77 -lm -lc   (in that order)
*/

#include "f2c.h"

/* Common Block Declarations */

struct {
    shortint first2;
    doublereal tl2, grtpst[3];
} robtrg_;

#define robtrg_1 robtrg_

struct {
    doublereal grlast[3], t0nav;
    shortint mnav;
    doublereal dtx0, dty0, dtz0;
} rnavig_;

#define rnavig_1 rnavig_

/*      PROGRAM EXOSIM */
/* ------------------------------------------------------------------
-C */
/* ---------------- Declare and initialize variables  ----------------
-C */
/* ------------------------------------------------------------------
-C */
/* Main program */ MAIN__()
{
    /* System generated locals */
    real r_1;
    doublereal d_1, d_2;

    /* Local variables */
    static doublereal delt, delu;
    static real s_gr__[3];
    static doublereal delv, delw;
    static real s_xd__, s_yd__, s_zd__;
    static doublereal rtic[15]      /* was [5][3] */, mass, rrel[3],
vtic[15]
          /* was [5][3] */, sphi, vrel[3], rmir[3], vmir[3], spsi, stht;
    static real s_pulsea__[3];
    static doublereal xyze[3];
    static real s_pulseg__[3];
    static doublereal timudriv, tgpudriv, timustep, tgpustep, t, x, y,
z;
    extern /* Subroutine */ int navig_();
    static doublereal dteps;
    static shortint iexit;
    static doublereal tstep, rtest[3], xyzed[3], vtest[3];
    extern /* Subroutine */ int receive_real_32bit__(),
receive_real_64bit__()
          ;
    static doublereal tuplk1, tuplk2, at[3], gr[3], xd, yd, zd, sp, sq,
sr,
          delphi, su, sv, sw, tfinal;
    extern /* Subroutine */ int obtarg_();
```

```
    static doublereal delpsi, deltnt;
    static real s_mass__;
    static doublereal pulsea[3];
    extern /* Subroutine */ int send_real_32bit__();
    static doublereal pulseg[3], grtest[3];
    extern /* Subroutine */ int imupro_();
    static doublereal qs1[4];
    extern /* Subroutine */ int estrel2_();
    static doublereal cie[9], rmi[3];
    extern /* Subroutine */ int cw87_();
    static doublereal vmi[3], grt[15]     /* was [5][3] */, sud, svd,
swd, ti2m[
          9];

/*     THE FOLLOWING COMMON BLOCKS USED FOR MIDFLIGHT CAPABILITIES ONLY
*/

/*     OUTPUTS */
/*     NAMELIST INPUTS */
/* DATA INITIALIZATION */
/* $INCLUDE('^/INCLUDE/SSDATA35.DAT') */
/* $INCLUDE('^/INCLUDE/SSDATA38.DAT') */
/* $INCLUDE('^/INCLUDE/SSDATA39.DAT') */
/* $INCLUDE('^/INCLUDE/SSDATA42.DAT') */
/* $INCLUDE('^/INCLUDE/SSDATA44.DAT') */
/* $INCLUDE('^/INCLUDE/SSDATA45.DAT') */
/* $INCLUDE('^/INCLUDE/SSDATA46.DAT') */
/* $INCLUDE('^/INCLUDE/SSDATA47.DAT') */
/* $INCLUDE('^/INCLUDE/SSDATA48.DAT') */
/* $INCLUDE('^/INCLUDE/SSDATA49.DAT') */
/* $INCLUDE('^/INCLUDE/SSDATA50.DAT') */
/* $INCLUDE('^/INCLUDE/SSDATA01.DAT') */
/* $INCLUDE('^/INCLUDE/SSDATA17.DAT') */
/* $INCLUDE('^/INCLUDE/SSDATA18.DAT') */
/* $INCLUDE('^/INCLUDE/SSDATA21.DAT') */
/* $INCLUDE('^/INCLUDE/SSDATA22.DAT') */
/* $INCLUDE('^/INCLUDE/SSDATA23.DAT') */
/* $INCLUDE('^/INCLUDE/SSDATA28.DAT') */
/* $INCLUDE('^/INCLUDE/SSDATA29.DAT') */
/* $INCLUDE('^/INCLUDE/SSDATA30.DAT') */
/* $INCLUDE('^/INCLUDE/SSDATA71.DAT') */
/* $INCLUDE('^/INCLUDE/SSTIMING.DAT') */
/* $INCLUDE('SSp01.DAT') */
/* INITIALIZE 80x87 */
    cw87_();
/*
-----------------------------------------------------------------
-----C */
/* ----------------------------- MAIN EXECUTION LOOP
--------------------C */
/*
-----------------------------------------------------------------
-----C */
/*                                Execution of all events is performed
C
*/
/*                                within this loop
C
*/
/*
C
*/
/*
-----------------------------------------------------------------
```

```
-----C */
L1000:
/*     WRITE(*,*)'--------------BEGINNING OF LOOP-----------------' */
/*
-----------------------------------------------------------------
-----C */
/* ----------------------- Processor communication
----------------------C */
/*
-----------------------------------------------------------------
-----C */
/* ----------------------- COMMUNICATION WITH P00
----------------------C */
    receive_real_32bit__(s_gr__);
    receive_real_32bit__(&s_gr__[1]);
    receive_real_32bit__(&s_gr__[2]);
    gr[0] = s_gr__[0];
    gr[1] = s_gr__[1];
    gr[2] = s_gr__[2];
    receive_real_32bit__(&s_mass__);
    mass = s_mass__;
    receive_real_32bit__(s_pulsea__);
    pulsea[0] = s_pulsea__[0];
    receive_real_32bit__(&s_pulsea__[1]);
    pulsea[1] = s_pulsea__[1];
    receive_real_32bit__(&s_pulsea__[2]);
    pulsea[2] = s_pulsea__[2];
    receive_real_32bit__(s_pulseg__);
    pulseg[0] = s_pulseg__[0];
    receive_real_32bit__(&s_pulseg__[1]);
    pulseg[1] = s_pulseg__[1];
    receive_real_32bit__(&s_pulseg__[2]);
    pulseg[2] = s_pulseg__[2];
    receive_real_64bit__(xyze);
    receive_real_64bit__(&xyze[1]);
    receive_real_64bit__(&xyze[2]);
    receive_real_64bit__(xyzed);
    receive_real_64bit__(&xyzed[1]);
    receive_real_64bit__(&xyzed[2]);
/* ----------------------- COMMUNICATION WITH SEEKER
--------------------C */
    receive_real_64bit__(&x);
    receive_real_64bit__(&y);
    receive_real_64bit__(&z);
    receive_real_32bit__(&s_xd__);
    receive_real_32bit__(&s_yd__);
    receive_real_32bit__(&s_zd__);
    xd = s_xd__;
    yd = s_yd__;
    zd = s_zd__;
/* ----------------------- COMMUNICATION WITH CORVEL
--------------------C */
    r_1 = rmir[0];
    send_real_32bit__(&r_1);
    r_1 = rmir[1];
    send_real_32bit__(&r_1);
    r_1 = rmir[2];
    send_real_32bit__(&r_1);
    r_1 = vmir[0];
    send_real_32bit__(&r_1);
    r_1 = vmir[1];
    send_real_32bit__(&r_1);
    r_1 = vmir[2];
    send_real_32bit__(&r_1);
```

```
    receive_real_64bit__(grt);
    receive_real_64bit__(&grt[5]);
    receive_real_64bit__(&grt[10]);
    receive_real_64bit__(rtic);
    receive_real_64bit__(&rtic[5]);
    receive_real_64bit__(&rtic[10]);
    receive_real_64bit__(vtic);
    receive_real_64bit__(&vtic[5]);
    receive_real_64bit__(&vtic[10]);
/* ----------------- COMMUNICATE WITH CORVEL --------------C */
    r_1 = at[0];
    send_real_32bit__(&r_1);
    r_1 = at[1];
    send_real_32bit__(&r_1);
    r_1 = at[2];
    send_real_32bit__(&r_1);
/* ---------------- DAISY CHAIN  -------------------C */
    r_1 = ti2m[0];
    send_real_32bit__(&r_1);
    r_1 = ti2m[1];
    send_real_32bit__(&r_1);
    r_1 = ti2m[2];
    send_real_32bit__(&r_1);
    r_1 = ti2m[3];
    send_real_32bit__(&r_1);
    r_1 = ti2m[4];
    send_real_32bit__(&r_1);
    r_1 = ti2m[5];
    send_real_32bit__(&r_1);
    r_1 = ti2m[6];
    send_real_32bit__(&r_1);
    r_1 = ti2m[7];
    send_real_32bit__(&r_1);
    r_1 = ti2m[8];
    send_real_32bit__(&r_1);
    r_1 = vrel[0];
    send_real_32bit__(&r_1);
    r_1 = vrel[1];
    send_real_32bit__(&r_1);
    r_1 = vrel[2];
    send_real_32bit__(&r_1);
    r_1 = rrel[0];
    send_real_32bit__(&r_1);
    r_1 = rrel[1];
    send_real_32bit__(&r_1);
    r_1 = rrel[2];
    send_real_32bit__(&r_1);
    r_1 = sp;
    send_real_32bit__(&r_1);
    r_1 = sq;
    send_real_32bit__(&r_1);
    r_1 = sr;
    send_real_32bit__(&r_1);
/*
-----------------------------------------------------------------
-----C */
/* ---------------------------- INERTIAL MEASUREMENT UPDATE
------------C */
/*
-----------------------------------------------------------------
-----C */
/*                              Get inertial measurement data needed
C
*/
```

```
/*                                  for guidance calculations .
C
*/
/*
C
*/
/*
-------------------------------------------------------------------
-----C */
    if (tstep >= timudriv) {
      timudriv += timustep;
/*
-------------------------------------------------------------
---------C */
/* ----------------------------- IMU PROCESSOR MODULE
--------------------C */
/*
-------------------------------------------------------------
---------C */
/*                                  Convert gyro and accelerometer
outputs  C */
/*                                  to delta angle and delta velocity
  C */
/*
  C */
/*
-------------------------------------------------------------
---------C */
      imupro_(&t, pulseg, pulsea, &delphi, &deltht, &delpsi, &delu,
&delv, &
            delw);
/*
-------------------------------------------------------------
---------C */
/* ----------------------------- NAVIGATION MODULE
----------------------C */
/*
-------------------------------------------------------------
---------C */
/*                                  This module calculates the
quaternions  C */
/*                                  and transformation matrices using
delta C */
/*                                  angles sensed by the gyro and
calculatesC */
/*                                  the interceptor velocity and position
  C */
/*                                  using delta velocity sensed by the
  C */
/*                                  accelerometer
  C */
/*
  C */
/*
-------------------------------------------------------------
---------C */
      navig_(&t, &mass, &delphi, &deltht, &delpsi, &delu, &delv, &delw,
gr,
            qsl, cie, &sp, &sq, &sr, &sud, &svd, &swd, vmir, rmir, ti2m,
&
            sphi, &stht, &spsi, &su, &sv, &sw, at, vmi, rmi);
    }
/*
-------------------------------------------------------------------
```

```
-----C */
/* ----------------------------- MIDCOURSE CORRECTION
-------------------C */
/*
-------------------------------------------------------------------
-----C */
/*                                Models uplink of interceptor,
C
*/
/*                                target, and intercept conditions
C
*/
/*
C
*/
/*
-------------------------------------------------------------------
-----C */
    if ((d_1 = t - tuplk1, abs(d_1)) <= dteps || (d_2 = t - tuplk2,
abs(d_2))
          <= dteps) {
/*        REVISE ESTIMATED MISSILE STATES */
      vmi[0] = xyzed[0];
      vmi[1] = xyzed[1];
      vmi[2] = xyzed[2];
      rmi[0] = xyze[0];
      rmi[1] = xyze[1];
      rmi[2] = xyze[2];
      vmir[0] = xd;
      vmir[1] = yd;
      vmir[2] = zd;
      rmir[0] = x;
      rmir[1] = y;
      rmir[2] = z;
      rnavig_1.t0nav = t;
    }
/*
-------------------------------------------------------------------
-----C */
/* ----------------------------- MIDCOURSE CORRECTION
-------------------C */
/*
-------------------------------------------------------------------
-----C */
/*                                Models uplink of interceptor,
C
*/
/*                                target, and intercept conditions
C
*/
/*
C
*/
/*
-------------------------------------------------------------------
-----C */
    if ((d_1 = t - tuplk1, abs(d_1)) <= dteps || (d_2 = t - tuplk2,
abs(d_2))
          <= dteps) {
/*        REVISE ESTIMATED TARGET STATES */
      rtest[0] = rtic[0];
      rtest[1] = rtic[5];
      rtest[2] = rtic[10];
      vtest[0] = vtic[0];
```

```
      vtest[1] = vtic[5];
      vtest[2] = vtic[10];
      grtest[0] = grt[0];
      grtest[1] = grt[5];
      grtest[2] = grt[10];
      robtrg_1.tl2 = t;
    }
/*
-----------------------------------------------------------------
-----C */
/*                              ON BOARD GUIDANCE PROCESSING
C
*/
/*
-----------------------------------------------------------------
-----C */
/*                              Determine guidance commands
C
*/
/*
C
*/
/*
-----------------------------------------------------------------
-----C */
    if (tstep >= tgpudriv) {
      tgpudriv += tgpustep;
/*
-----------------------------------------------------------------
---------C */
/* ---------------------------- ON BOARD TARGET MODULE
------------------C */
/*
-----------------------------------------------------------------
---------C */
/*                              Estimate target position based on
  C */
/*                              predicted intercept conditions
  C */
/*
  C */
/*
-----------------------------------------------------------------
---------C */
/*        GRTEST TEMPORARILY EQUAL TO GRT */
      grtest[0] = grt[0];
      grtest[1] = grt[5];
      grtest[2] = grt[10];
      obtarg_(&t, grtest, rtest, vtest);
      estrel2_(rtest, vtest, rmir, vmir, rrel, vrel);
    }
/*
-----------------------------------------------------------------
-----C */
/* ---------------------------- TERMINATION LOGIC
----------------------------C */
/*
-----------------------------------------------------------------
-----C */
/*                               Defines the simulation termination
C
*/
/*                               conditions
C
```

```
*/
/*
C
*/
/*
-------------------------------------------------------------
-----C */
/*     INITIALIZE SIMULATION EXIT FLAG TO ZERO ( PREVENTS EXIT ) */
    iexit = 0;
/*     ENABLE EXIT IF MAXIMUM SIMULATION TIME HAS BEEN EXECUTED AND ALL
*/

/*     EVENTS SCHEDULED FOR THIS TIME HAVE BEEN EXECUTED */
    if (t >= tfinal) {
      iexit = 1;
    }
/*     increment time */
    tstep += 1.;
    t = tstep * delt;
/*     CONTINUE LOOPING UNTIL ONE OR MORE EXIT CONDITIONS HAVE BEEN MET
*/

    if (iexit == 0) {
      goto L1000;
    }
} /* MAIN__ */
```

### B.3.3 Uup02.c

```
/* uup02.f -- translated by f2c (version of 3 February 1990  3:36:42).
   You must link the resulting object file with the libraries:
      -lF77 -lI77 -lm -lc    (in that order)
*/

#include "f2c.h"

/* Common Block Declarations */

struct {
    real tmefl, tlstv, tmvcs[24]   /* was [6][4] */, thvcs[24]   /*
          was [6][4] */;
    shortint lenvcs[4];
} rvcstr_;

#define rvcstr_1 rvcstr_

/*      PROGRAM EXOSIM */
/* ----------------------------------------------------------------------
-C */
/* --------------- Declare and initialize variables  ------------------
-C */
/* ----------------------------------------------------------------------
-C */
/* Main program */ MAIN__()
{
    static real delt, tbrk;
    static shortint ivcs;
    static real foff1[4], foff2[4], tmsudriv, tmsustep, t;
    static shortint ivtab;
    static real tvtab;
    static shortint iexit;
    static real mdotv, fxvcs, fyvcs, fzvcs, tstep, mxvcs, myvcs, mzvcs,
tkvon;

    extern /* Subroutine */ int receive_real_32bit__();
    static real cg[3], dtoffv[4];
    extern /* Subroutine */ int send_real_32bit__();
    static real tofflt[4], tburnm;
    extern /* Subroutine */ int vcsthr_();
    static real timonv;
    extern /* Subroutine */ int cw87_(), receive_signed_16bit__();

/*     THE FOLLOWING COMMON BLOCK USED FOR MIDFLIGHT CAPABILITIES ONLY
*/
/* DATA INITIALIZATION */
/* $INCLUDE('^/INCLUDE/SSDATA35.DAT') */
/* $INCLUDE('^/INCLUDE/SSDATA38.DAT') */
/* $INCLUDE('^/INCLUDE/SSDATA39.DAT') */
/* $INCLUDE('^/INCLUDE/SSDATA42.DAT') */
/* $INCLUDE('^/INCLUDE/SSDATA44.DAT') */
/* $INCLUDE('^/INCLUDE/SSDATA45.DAT') */
/* $INCLUDE('^/INCLUDE/SSDATA46.DAT') */
/* $INCLUDE('^/INCLUDE/SSDATA47.DAT') */
/* $INCLUDE('^/INCLUDE/SSDATA48.DAT') */
/* $INCLUDE('^/INCLUDE/SSDATA49.DAT') */
/* $INCLUDE('^/INCLUDE/SSDATA50.DAT') */
/* $INCLUDE('^/INCLUDE/SSDATA01.DAT') */
/* $INCLUDE('^/INCLUDE/SSDATA17.DAT') */
/* $INCLUDE('^/INCLUDE/SSDATA18.DAT') */
/* $INCLUDE('^/INCLUDE/SSDATA21.DAT') */
```

```
/* $INCLUDE('^/INCLUDE/SSDATA22.DAT') */
/* $INCLUDE('^/INCLUDE/SSDATA23.DAT') */
/* $INCLUDE('^/INCLUDE/SSDATA28.DAT') */
/* $INCLUDE('^/INCLUDE/SSDATA29.DAT') */
/* $INCLUDE('^/INCLUDE/SSDATA30.DAT') */
/* $INCLUDE('^/INCLUDE/SSDATA71.DAT') */
/* $INCLUDE('^/INCLUDE/SSTIMING.DAT') */
/* $INCLUDE('SSp02.DAT') */
/* INITIALIZE 80x87 */
    cw87_();
/*
-----------------------------------------------------------------
-----C */
/* ----------------------------- MAIN EXECUTION LOOP
-------------------C */
/*
-----------------------------------------------------------------
-----C */
/*                                Execution of all events is performed
C
*/
/*                                within this loop
C
*/
/*
C
*/
/*
-----------------------------------------------------------------
-----C */
L1000:
/*     WRITE(*,*)'--------------BEGINNING OF LOOP-----------------' */
/*
-----------------------------------------------------------------
-----C */
/* ---------------------------- MISSILE STATE UPDATE MODULE
--------------C */
/*
-----------------------------------------------------------------
-----C */
/*                              Integrate missile states to current time
C
*/
/*
C
*/
/*
-----------------------------------------------------------------
-----C */
/* --------- receive from masspr (P00) ----------C */
    receive_real_32bit__(cg);
    receive_real_32bit__(&cg[1]);
    receive_real_32bit__(&cg[2]);
/* --------- Send variables to masspr and missil (p00)
----------------C */
    send_real_32bit__(&mdotv);
    send_real_32bit__(&fxvcs);
    send_real_32bit__(&fyvcs);
    send_real_32bit__(&fzvcs);
    send_real_32bit__(&mxvcs);
    send_real_32bit__(&myvcs);
    send_real_32bit__(&mzvcs);
/* ---------- Communication with p01 -----------------C */
    receive_real_32bit__(dtoffv);
```

```
    receive_real_32bit__(&dtoffv[1]);
    receive_real_32bit__(&dtoffv[2]);
    receive_real_32bit__(&dtoffv[3]);
    receive_signed_16bit__(&ivcs);
    receive_signed_16bit__(&ivtab);
    receive_real_32bit__(&tburnm);
    receive_real_32bit__(&timonv);
    receive_real_32bit__(toffIt);
    receive_real_32bit__(&tofflt[1]);
    receive_real_32bit__(&tofflt[2]);
    receive_real_32bit__(&tofflt[3]);
    receive_real_32bit__(&tvtab);
    if (tstep >= tmsudriv) {
      tmsudriv += tmsustep;
/*
---------------------------------------------------------------
---------C */
/* ------------------------------ VCS THRUSTER RESPONSE MODULE
------------C */
/*
---------------------------------------------------------------
---------C */
/*                                Determines the forces and moments
  C */
/*                                imparted by the VCS thrusters
  C */
/*
  C */
/*
---------------------------------------------------------------
---------C */
      if (t >= tkvon) {
          vcsthr_(&t, cg, &tburnm, &ivcs, tofflt, &timonv, dtoffv,
&tvtab,
                foff1, foff2, &ivtab, &tbrk, &fxvcs, &fyvcs, &fzvcs, &
                mxvcs, &myvcs, &mzvcs, &mdotv);
      }
    }
/*
---------------------------------------------------------------
-----C */
/* ---------------------------- TERMINATION LOGIC
----------------------C */
/*
---------------------------------------------------------------
-----C */
/*                                Defines the simulation termination
C
*/
/*                                conditions
C
*/
/*
C
*/
/*
---------------------------------------------------------------
-----C */
/*     INITIALIZE SIMULATION EXIT FLAG TO ZERO ( PREVENTS EXIT ) */
    iexit = 0;
/*     increment time */
    tstep += (float)1.;
    t = tstep * delt;
```

```
/*     CONTINUE LOOPING UNTIL ONE OR MORE EXIT CONDITIONS HAVE BEEN MET
*/

    if (iexit == 0) {
      goto L1000;
    }
} /* MAIN__ */

/* uup02.f -- translated by f2c (version of 3 February 1990  3:36:42).
   You must link the resulting object file with the libraries:
      -lF77 -lI77 -lm -lc    (in that order)
*/

#include "f2c.h"

/* Common Block Declarations */

struct {
    real treflv, tlstv, tmvcs[24]   /* was [6][4] */, thvcs[24]   /*
          was [6][4] */;
    shortint lenvcs[4];
} rvcstr_;

#define rvcstr_1 rvcstr_

/*      PROGRAM EXOSIM */
/* ----------------------------------------------------------------------
-C */
/* ---------------- Declare and initialize variables  ------------------
-C */
/* ----------------------------------------------------------------------
-C */
/* Main program */ MAIN__()
{
    static real delt, tbrk;
    static shortint ivcs;
    static real foff1[4], foff2[4], tmsudriv, tmsustep, t;
    static shortint ivtab;
    static real tvtab;
    static shortint iexit;
    static real mdotv, fxvcs, fyvcs, fzvcs, tstep, mxvcs, myvcs, mzvcs,
tkvon;

    extern /* Subroutine */ int receive_real_32bit__();
    static real cg[3], dtoffv[4];
    extern /* Subroutine */ int send_real_32bit__();
    static real tofflt[4], tburnm;
    extern /* Subroutine */ int vcsthr_();
    static real timonv;
    extern /* Subroutine */ int cw87_(), receive_signed_16bit__();

/*     THE FOLLOWING COMMON BLOCK USED FOR MIDFLIGHT CAPABILITIES ONLY
*/
/* DATA INITIALIZATION */
/* $INCLUDE('^/INCLUDE/SSDATA35.DAT') */
/* $INCLUDE('^/INCLUDE/SSDATA38.DAT') */
/* $INCLUDE('^/INCLUDE/SSDATA39.DAT') */
/* $INCLUDE('^/INCLUDE/SSDATA42.DAT') */
/* $INCLUDE('^/INCLUDE/SSDATA44.DAT') */
/* $INCLUDE('^/INCLUDE/SSDATA45.DAT') */
/* $INCLUDE('^/INCLUDE/SSDATA46.DAT') */
/* $INCLUDE('^/INCLUDE/SSDATA47.DAT') */
/* $INCLUDE('^/INCLUDE/SSDATA48.DAT') */
/* $INCLUDE('^/INCLUDE/SSDATA49.DAT') */
```

```
/* $INCLUDE('^/INCLUDE/SSDATA50.DAT') */
/* $INCLUDE('^/INCLUDE/SSDATA01.DAT') */
/* $INCLUDE('^/INCLUDE/SSDATA17.DAT') */
/* $INCLUDE('^/INCLUDE/SSDATA18.DAT') */
/* $INCLUDE('^/INCLUDE/SSDATA21.DAT') */
/* $INCLUDE('^/INCLUDE/SSDATA22.DAT') */
/* $INCLUDE('^/INCLUDE/SSDATA23.DAT') */
/* $INCLUDE('^/INCLUDE/SSDATA28.DAT') */
/* $INCLUDE('^/INCLUDE/SSDATA29.DAT') */
/* $INCLUDE('^/INCLUDE/SSDATA30.DAT') */
/* $INCLUDE('^/INCLUDE/SSDATA71.DAT') */
/* $INCLUDE('^/INCLUDE/SSTIMING.DAT') */
/* $INCLUDE('SSp02.DAT') */
/* INITIALIZE 80x87 */
    cw87_();
/*
-----------------------------------------------------------------
-----C */
/* ---------------------------------- MAIN EXECUTION LOOP
--------------------C */
/*
-----------------------------------------------------------------
-----C */
/*                                Execution of all events is performed
C
*/
/*                                within this loop
C
*/
/*
C
*/
/*
-----------------------------------------------------------------
-----C */
L1000:
/*     WRITE(*,*)'--------------BEGINNING OF LOOP-----------------' */
/*
-----------------------------------------------  ---------------
-----C */
/* ------------ -------------- MISSILE STATE UPDATE MODULE
--------------C */
/*
-----------------------------------------------------------------
-----C */
/*                              Integrate missile states to current time
C
*/
/*
C
*/
/*
-----------------------------------------------------------------
-----C */
/* --------- recieve from masspr (P00) ----------C */
    receive_real_32bit__(cg);
    receive_real_32bit__(&cg[1]);
    receive_real_32bit__(&cg[2]);
/* --------- Send variables to masspr and missil (p00)
------------------C */
    send_real_32bit__(&mdotv);
    send_real_32bit__(&fxvcs);
    send_real_32bit__(&fyvcs);
    send_real_32bit__(&fzvcs);
```

```
    send_real_32bit__(&mxvcs);
    send_real_32bit__(&myvcs);
    send_real_32bit__(&mzvcs);
/* ---------- Communication with p01 -----------------C */
    receive_real_32bit__(dtoffv);
    receive_real_32bit__(&dtoffv[1]);
    receive_real_32bit__(&dtoffv[2]);
    receive_real_32bit__(&dtoffv[3]);
    receive_signed_16bit__(&ivcs);
    receive_signed_16bit__(&ivtab);
    receive_real_32bit__(&tburnm);
    receive_real_32bit__(&timonv);
    receive_real_32bit__(tofflt);
    receive_real_32bit__(&tofflt[1]);
    receive_real_32bit__(&tofflt[2]);
    receive_real_32bit__(&tofflt[3]);
    receive_real_32bit__(&tvtab);
    if (tstep >= tmsudriv) {
      tmsudriv += tmsustep;
/*
-------------------------------------------------------------
---------C */
/* ---------------------------- VCS THRUSTER RESPONSE MODULE
-----------C */
/*
-------------------------------------------------------------
---------C */
/*                                Determines the forces and moments
  C */
/*                                imparted by the VCS thrusters
  C */
/*
  C */
/*
-------------------------------------------------------------
---------C */
      if (t >= tkvon) {
          vcsthr_(&t, cg, &tburnm, &ivcs, tofflt, &timonv, dtoffv,
&tvtab,
                foff1, foff2, &ivtab, &tbrk, &fxvcs, &fyvcs, &fzvcs, &
                mxvcs, &myvcs, &mzvcs, &mdotv);
      }
    }
/*
-------------------------------------------------------------
-----C */
/* ---------------------------- TERMINATION LOGIC
----------------------C */
/*
-------------------------------------------------------------
-----C */
/*                                Defines the simulation termination
C
*/
/*                                conditions
C
*/
/*
C
*/
/*
-------------------------------------------------------------
-----C */
/*     INITIALIZE SIMULATION EXIT FLAG TO ZERO ( PREVENTS EXIT ) */
```

```
    iexit = 0;
/*      increment time */
    tstep += (float)1.;
    t = tstep * delt;
/*      CONTINUE LOOPING UNTIL ONE OR MORE EXIT CONDITIONS HAVE BEEN MET
*/

    if (iexit == 0) {
      goto L1000;
    }
} /* MAIN__ */
```

### B.3.4 Uup03.c

```
/* uup03.f -- translated by f2c (version of 3 February 1990  3:36:42).
   You must link the resulting object file with the libraries:
      -lF77 -lI77 -lm -lc   (in that order)
*/

#include "f2c.h"

/* Common Block Declarations */

struct {
    doublereal tl1, grtlst[15]      /* was [5][3] */;
    shortint first1;
} rtarg_;

#define rtarg_1 rtarg_

/* Table of constant values */

static real c_b2 = (float)0.;
static shortint cs__1 = 1;
static shortint cs__2 = 2;
static shortint cs__3 = 3;
static integer c__1 = 1;

/*      PROGRAM EXOSIM */
/* ----------------------------------------------------------------------
-C */
/* --------------- Declare and initialize variables  ------------------
-C */
/* ----------------------------------------------------------------------
-C */
/* Main program */ MAIN__()
{

    /* Format strings */
    static char fmt_889[] = "(1x,e16.9,\002 MISS = \002,e16.9)";

    /* System generated locals */
    real r_1;
    doublereal d_1, d_2, d_3;

    /* Builtin functions */
    double sqrt();
    integer s_wsfi(), do_fio(), e_wsfi();

    /* Local variables */
    static doublereal delt, rtic[15]      /* was [5][3] */;
    static real tphi;
    static doublereal latt, rtar[3], miss;
    static real tpsi;
    static doublereal rtei[3], vtar[3];
    static real ttht;
    static doublereal vtic[15]      /* was [5][3] */;
    extern /* Subroutine */ int send_signed_16bit__();
    static doublereal tmsudriv, trsudriv, ttsudriv, tmsustep, trsustep,
          ttsustep;
    static real q, r;
    static doublereal t, x, y, z;
    static real tphid, ptarg, qtarg, rtarg, tpsid;
    static doublereal longt;
    static real tthtd;
```

```
    static doublereal rrelm[3], vrelm[3], tstep;
    extern /* Subroutine */ int receive_real_32bit__(),
receive_real_64bit__()
          , spmmk_(), relat_();
    static doublereal tgotr, xmiss, ymiss, zmiss;
    static shortint iexit;
    static doublereal tgomn;
    static real xd, yd, zd;
    static doublereal lamsek[2], lamdsk[2], maglos, lamdtr[2], magrtr,
mgrdtr,
           lamdxx[2], lamtru[2], rreltr[3], vreltr[3], rj[5];
    extern /* Subroutine */ int send_real_64bit__();
    static shortint ireslv;
    extern /* Subroutine */ int send_real_32bit__();
    static doublereal cie[9], omegae;
    extern /* Subroutine */ int target_(), outcmes_();
    static real cim[9], cer[9], cit[9], cti[9];
    static doublereal cms[9], grt[15]     /* was [5][3] */;
    static char message[128];
    extern /* Subroutine */ int cw87_();

    /* Fortran I/O blocks */
    static icilist io__68 = { 0, message, 0, fmt_889, 128, 1 };


/*     THE FOLLOWING COMMON BLOCKS USED FOR MIDFLIGHT CAPABILITIES ONLY
*/

/*     OUTPUTS */
/*     NAMELIST INPUTS */
/* DATA INITIALIZATION */
/* $INCLUDE('^/INCLUDE/SSDATA35.DAT') */
/* $INCLUDE('^/INCLUDE/SSDATA38.DAT') */
/* $INCLUDE('^/INCLUDE/SSDATA39.DAT') */
/* $INCLUDE('^/INCLUDE/SSDATA42.DAT') */
/* $INCLUDE('^/INCLUDE/SSDATA44.DAT') */
/* $INCLUDE('^/INCLUDE/SSDATA45.DAT') */
/* $INCLUDE('^/INCLUDE/SSDATA46.DAT') */
/* $INCLUDE('^/INCLUDE/SSDATA47.DAT') */
/* $INCLUDE('^/INCLUDE/SSDATA48.DAT') */
/* $INCLUDE('^/INCLUDE/SSDATA49.DAT') */
/* $INCLUDE('^/INCLUDE/SSDATA50.DAT') */
/* $INCLUDE('^/INCLUDE/SSDATA01.DAT') */
/* $INCLUDE('^/INCLUDE/SSDATA17.DAT') */
/* $INCLUDE('^/INCLUDE/SSDATA18.DAT') */
/* $INCLUDE('^/INCLUDE/SSDATA21.DAT') */
/* $INCLUDE('^/INCLUDE/SSDATA22.DAT') */
/* $INCLUDE('^/INCLUDE/SSDATA23.DAT') */
/* $INCLUDE('^/INCLUDE/SSDATA28.DAT') */
/* $INCLUDE('^/INCLUDE/SSDATA29.DAT') */
/* $INCLUDE('^/INCLUDE/SSDATA30.DAT') */
/* $INCLUDE('^/INCLUDE/SSDATA71.DAT') */
/* $INCLUDE('^/INCLUDE/SSTIMING.DAT') */
/* $INCLUDE('^/INCLUDE/SSMAS_cg.DAT') */
/* INITIALIZE 80x87 */
    cw87_();
/* $INCLUDE('SSp03.DAT') */
/*
---------- ------------------------------------------------------
-----C */
/* ---------------------------- MAIN EXECUTION LOOP
--------------------C */
/*
-------------------------------------------------------------------
```

```
-----C */
/*                                  Execution of all events is performed
C
*/
/*                                  within this loop
C
*/
/*
C
*/
/*
------------------------------------------------------------
-----C */
L1000:
/*
------------------------------------------------------------------
-----C */
/* ------------------------ Processor communication
-----------------------C */
/*
-------------------------------------------------------------
-----C */
/* -------------  Communicate with p00 --------------------------------C
*/
    receive_real_32bit__(&q);
    receive_real_32bit__(&r);
    receive_real_64bit__(&x);
    receive_real_64bit__(&y);
    receive_real_64bit__(&z);
    receive_real_32bit__(&xd);
    receive_real_32bit__(&yd);
    receive_real_32bit__(&zd);
    receive_real_32bit__(cim);
    receive_real_32bit__(&cim[1]);
    receive_real_32bit__(&cim[2]);
    receive_real_32bit__(&cim[3]);
    receive_real_32bit__(&cim[4]);
    receive_real_32bit__(&cim[5]);
    receive_real_32bit__(&cim[6]);
    receive_real_32bit__(&cim[7]);
    receive_real_32bit__(&cim[8]);
/* -------------  Communicate with p01 -------------------------------
C
*/
    send_real_64bit__(grt);
    send_real_64bit__(&grt[5]);
    send_real_64bit__(&grt[10]);
    send_signed_16bit__(&ireslv);
    r_1 = lamdxx[0];
    send_real_32bit__(&r_1);
    r_1 = lamdxx[1];
    send_real_32bit__(&r_1);
    r_1 = lamsek[0];
    send_real_32bit__(&r_1);
    r_1 = lamsek[1];
    send_real_32bit__(&r_1);
    r_1 = magrtr;
    send_real_32bit__(&r_1);
    send_real_64bit__(rtic);
    send_real_64bit__(&rtic[5]);
    send_real_64bit__(&rtic[10]);
    send_real_64bit__(vtic);
    send_real_64bit__(&vtic[5]);
    send_real_64bit__(&vtic[10]);
```

```
/*     WRITE(*,*)'--------------BEGINNING OF LOOP-----------------' */
    if (tstep >= tmsudriv) {
      tmsudriv += tmsustep;
/*        ROTATING EARTH MODEL */
      r_1 = omegae * t;
      spmmk_(&c_b2, &cs__1, &c_b2, &cs__2, &r_1, &cs__3, cer);
    }
/*
-----------------------------------------------------------------
-----C */
/* ----------------------------- RELATIVE STATES MODULE
-----------------C */
/*
-----------------------------------------------------------------
-----C */
/*                                Calculate relative range, range rate,
C
*/
/*                                time-tc-go, LOS angles and rates
C
*/
/*
C
*/
/*
-----------------------------------------------------------------
-----C */
    if (tstep >= trsudriv) {
      trsudriv += trsustep;
      relat_(rtic, vtic, &x, &y, &z, &xd, &yd, &zd, &q, &r, cim, cms,
            rreltr, &magrtr, vreltr, &mgrdtr, &maglos, lamtru, lamdt,
            lamdtr, lamsek, lamdsk, &tgotr, rrelm, vrelm);
/*        EXTRAPOLATE POINT OF CLOSEST APPROACH */
      xmiss = rreltr[0] + tgotr * vreltr[0];
      ymiss = rreltr[1] + tgotr * vreltr[1];
      zmiss = rreltr[2] + tgotr * vreltr[2];
/* Computing 2nd power */
      d_1 = xmiss;
/* Computing 2nd power */
      d_2 = ymiss;
/* Computing 2nd power */
      d_3 = zmiss;
      miss = sqrt(d_1 * d_1 + d_2 * d_2 + d_3 * d_3);
    }
/*
-----------------------------------------------------------------
-----C */
/* ----------------------------- TARGET STATES MODULE
-------------------C */
/*
-----------------------------------------------------------------
-----C */
/*                                This module calculates the true exo-
C
*/
/*                                atmospheric trajectory data for
C
*/
/*                                the target
C
*/
/*
C
*/
```

```
/*
-----------------------------------------------------------------
-----C */
    if (tstep >= ttsudriv) {
      ttsudriv += ttsustep;
      target_(&t, &magrtr, cer, cie, &ptarg, &qtarg, &rtarg, &tphi,
&ttht, &
            tpsi, gr&, &tphid, &tthtd, &tpsid, cit, rtic, vtic, rtar,
            rter, &ireslv, rj, cti, vtar, &latt, &longt);
    }
/*
-----------------------------------------------------------------
-----C */
/* ------------------------------ TERMINATION LOGIC
----------------------C */
/*
-----------------------------------------------------------------
-----C */
/*                                Defines the simulation termination
C
*/
/*                                conditions
C
*/
/*
C
*/
/*
-----------------------------------------------------------------
-----C */
/*     INITIALIZE SIMULATION EXIT FLAG TO ZERO ( PREVENTS EXIT ) */
    iexit = 0;
/*     ENABLE EXIT IF INTERCEPT HAS OCCURRED AND ALL EVENTS SCHEDULED
FOR
*/
/*     THIS TIME HAVE BEEN EXECUTED */
    if (tgotr <= tgomn) {
      iexit = 1;
    }
/*     increment time */
    tstep += 1.;
    t = tstep * delt;
/*     CONTINUE LOOPING UNTIL ONE OR MORE EXIT CONDITIONS HAVE BEEN MET
*/

    if (iexit == 0) {
      goto L1000;
    }
/*
-----------------------------------------------------------------
-----C */
/* ----------------------------- POINT OF CLOSEST APPROACH CALCULATION
--C */
/*
-----------------------------------------------------------------
-----C */
/*                                Determines the miss distance at the
C
*/
/*                                point of closest approach
C
*/
/*
C
```

```
*/
/*
----------------------------------------------------------------
-----C */
/* Computing 2nd power */
    d_1 = rreltr[0] + vreltr[0] * tgotr;
/* Computing 2nd power */
    d_2 = rreltr[1] + vreltr[1] * tgotr;
/* Computing 2nd power */
    d_3 = rreltr[2] + vreltr[2] * tgotr;
    miss = sqrt(d_1 * d_1 + d_2 * d_2 + d_3 * d_3);
    s_wsfi(&io__68);
    do_fio(&c__1, (char *)&t, (ftnlen)sizeof(doublereal));
    do_fio(&c__1, (char *)&miss, (ftnlen)sizeof(doublereal));
    e_wsfi();
    outmes_(message, 128L);
} /* MAIN__ */
```

### B.3.5 Uup04.c

```
/* uup04.f -- translated by f2c (version of 3 February 1990  3:36:42).
   You must link the resulting object file with the libraries:
      -lF77 -lI77 -lm -lc   (in that order)
*/

#include "f2c.h"

/* Common Block Declarations */

struct {
    doublereal gset;
    shortint iset;
} norcom_;

#define norcom_1 norcom_

struct {
    real ranseq[97], ranlst;
} rancom_;

#define rancom_1 rancom_

struct {
    doublereal psig, thtg, phig, thxzg, thxyg, thyzg, thyxg, thzyg,
thzxg,
            sf1g[3], sf2g[3], dcg[3], t0gyro, cimo[9], wbi2[3], wbi1[3],
wbo2[
            3], wbo1[3], drsigg;
} rgyro_;

#define rgyro_1 rgyro_

/*     PROGRAM EXOSIM */
/* ------------------------------------------------------------------------
-C */
/* ---------------- Declare and initialize variables  -------------------
-C */.
/* ------------------------------------------------------------------------
-C */
/* Main program */ MAIN__()
{
    /* System generated locals */
    real r_1;

    /* Local variables */
    static doublereal delt;
    extern /* Subroutine */ int gyro_();
    static doublereal timudriv, timustep, p, q, r, t;
    static real s_cim__[9];
    static shortint iexit;
    static doublereal tstep;
    extern /* Subroutine */ int receive_real_32bit__();
    static doublereal qfracg[3];
    static integer gyseed;
    extern /* Subroutine */ int send_real_32bit__();
    static doublereal pulseg[3], cim[9];
    static real s_p__, s_q__, s_r__;
    extern /* Subroutine */ int cw87_();

/*     THE FOLLOWING COMMON BLOCKS USED FOR MIDFLIGHT CAPABILITIES ONLY
*/
```

```
/* DATA INITIALIZATION */
/* $include ('^/include/ssdata35.dat') */
/* $include ('^/include/ssdata38.dat') */
/* $include ('^/include/ssdata39.dat') */
/* $include ('^/include/ssdata42.dat') */
/* $include ('^/include/ssdata44.dat') */
/* $include ('^/include/ssdata45.dat') */
/* $include ('^/include/ssdata46.dat') */
/* $include ('^/include/ssdata47.dat') */
/* $include ('^/include/ssdata48.dat') */
/* $include ('^/include/ssdata49.dat') */
/* $include ('^/include/ssdata50.dat') */
/* $include ('^/include/ssdata01.dat') */
/* $include ('^/include/ssdata17.dat') */
/* $include ('^/include/ssdata18.dat') */
/* $include ('^/include/ssdata21.dat') */
/* $include ('^/include/ssdata22.dat') */
/* $include ('^/include/ssdata23.dat') */
/* $include ('^/include/ssdata28.dat') */
/* $include ('^/include/ssdata29.dat') */
/* $include ('^/include/ssdata30.dat') */
/* $include ('^/include/ssdata71.dat') */
/* $include ('^/include/sstiming.dat') */
    cw87_();
/* $include ('ssp04.dat') */
/*
-------------------------------------------------------------------
-----C */
/* ------------------------------ MAIN EXECUTION LOOP
--------------------C */
/*
-------------------------------------------------------------------
-----C */
/*                                Execution of all events is performed
C
*/
/*                                within this loop
C
*/
/*
C
*/
/*
-------------------------------------------------------------------
-----C */
L1000:
/*     WRITE(*,*)'--------------BEGINNING OF LOOP-----------------' */
/*
-------------------------------------------------------------------
-----C */
/* ------------------------ Processor communication
----------------------C */
/*
-------------------------------------------------------------------
-----C */
/* -------------------  Communicate with p01
----------------------------C */
    r_1 = pulseg[0];
    send_real_32bit__(&r_1);
    r_1 = pulseg[1];
    send_real_32bit__(&r_1);
    r_1 = pulseg[2];
    send_real_32bit__(&r_1);
```

```
    receive_real_32bit__(&s_p__);
    receive_real_32bit__(&s_q__);
    receive_real_32bit__(&s_r__);
    p = (doublereal) s_p__;
    q = (doublereal) s_q__;
    r = (doublereal) s_r__;
    receive_real_32bit__(s_cim__);
    receive_real_32bit__(&s_cim__[1]);
    receive_real_32bit__(&s_cim__[2]);
    receive_real_32bit__(&s_cim__[3]);
    receive_real_32bit__(&s_cim__[4]);
    receive_real_32bit__(&s_cim__[5]);
    receive_real_32bit__(&s_cim__[6]);
    receive_real_32bit__(&s_cim__[7]);
    receive_real_32bit__(&s_cim__[8]);
    cim[0] = (doublereal) s_cim__[0];
    cim[1] = (doublereal) s_cim__[1];
    cim[2] = (doublereal) s_cim__[2];
    cim[3] = (doublereal) s_cim__[3];
    cim[4] = (doublereal) s_cim__[4];
    cim[5] = (doublereal) s_cim__[5];
    cim[6] = (doublereal) s_cim__[6];
    cim[7] = (doublereal) s_cim__[7];
    cim[8] = (doublereal) s_cim__[8];
/*
-----------------------------------------------------------------------
-----C */
/* ---------------------------- INERTIAL MEASUREMENT UPDATE
------------C */
/*
-----------------------------------------------------------------------
-----C */
/*                                Get inertial measurement data needed
C
*/
/*                                for guidance calculations .
C
*/
/*
C
*/
/*
-----------------------------------------------------------------------
-----C */
    if (tstep >= timudriv) {
      timudriv += timustep;
/*
------------ ----------------------------------------------------
---------C */
/* ---------------------------- GYRO MODULE
----------------------------C */
/*
-----------------------------------------------------------------
---------C */
/*                                Determine sensed body rates .
  C */
/*
  C */
/*
-----------------------------------------------------------------
---------C */
      gyro_(&t, &p, &q, &r, cim, &gyseed, qfracg, pulseg);
    }
/*
```

```
------------------------------------------------------------------
-----C */
/* ------------------------------ TERMINATION LOGIC
-----------------------C */
/*
------------------------------------------------------------------
-----C */
/*                                Defines the simulation termination
C
*/
/*                                conditions
C
*/
/*
C
*/
/*
------------------------------------------------------------------
-----C */
/*     INITIALIZE SIMULATION EXIT FLAG TO ZERO ( PREVENTS EXIT ) */
    iexit = 0;
/*     increment time */
    tstep += 1.;
    t = tstep * delt;
/*     CONTINUE LOOPING UNTIL ONE OR MORE EXIT CONDITIONS HAVE BEEN MET
*/

    if (iexit == 0) {
      goto L1000;
    }
} /* MAIN__ */
```

### B.3.6 Uup05.c

```
/* uup05.f -- translated by f2c (version of 3 February 1990  3:36:42).
   You must link the resulting object file with the libraries:
      -lF77 -lI77 -lm -lc   (in that order)
*/

#include "f2c.h"

/* Common Block Declarations */

struct {
    real gset;
    shortint iset;
} norcom_;

#define norcom_1 norcom_

struct {
    real ranseq[97], ranlst;
} rancom_;

#define rancom_1 rancom_

struct {
    real trefla, tlstc, acsf, aoff1[4], aoff2[4], tmacsa[32]      /* was
[8][4]
          */, thacsa[32]      /* was [8][4] */;
    shortint lena[4];
    real tmacsb[32]     /* was [8][4] */, thacsb[32]  /* was [8][4] */;
    shortint lenb[4];
} racstr_;

#define racstr_1 racstr_

/*      PROGRAM EXOSIM */
/* ------------------------------------------------------------------
-C */
/* ---------------- Declare and initialize variables  ----------------
-C */
/* ------------------------------------------------------------------
-C */
/* Main program */ MAIN__()
{
    static real delt, tbrk;
    extern /* Subroutine */ int send_signed_16bit__();
    static real tmsudriv, tmsustep, t, tatab, mdota, fxacs, fyacs,
fzacs,
          mxacs, myacs, mzacs;
    static shortint iexit;
    static real tstep, tkvon;
    extern /* Subroutine */ int receive_real_32bit__();
    static real cg[3], dtacsa[4], dtacsb[4];
    static shortint iacson;
    static real acslev;
    static integer toseed;
    extern /* Subroutine */ int acsthr_();
    static real timona;
    extern /* Subroutine */ int send_real_32bit__();
    static shortint ithres;
    extern /* Subroutine */ int cw87_(), receive_signed_16bit__();
```

```
/*     THE FOLLOWING COMMON BLOCK USED FOR MIDFLIGHT CAPABILITIES ONLY
*/
/* DATA INITIALIZATION */
/* $INCLUDE('^/INCLUDE/SSDATA35.DAT') */
/* $INCLUDE('^/INCLUDE/SSDATA38.DAT') */
/* $INCLUDE('^/INCLUDE/SSDATA39.DAT') */
/* $INCLUDE('^/INCLUDE/SSDATA42.DAT') */
/* $INCLUDE('^/INCLUDE/SSDATA44.DAT') */
/* $INCLUDE('^/INCLUDE/SSDATA45.DAT') */
/* $INCLUDE('^/INCLUDE/SSDATA46.DAT') */
/* $INCLUDE('^/INCLUDE/SSDATA47.DAT') */
/* $INCLUDE('^/INCLUDE/SSDATA48.DAT') */
/* $INCLUDE('^/INCLUDE/SSDATA49.DAT') */
/* $INCLUDE('^/INCLUDE/SSDATA50.DAT') */
/* $INCLUDE('^/INCLUDE/SSDATA01.DAT') */
/* $INCLUDE('^/INCLUDE/SSDATA17.DAT') */
/* $INCLUDE('^/INCLUDE/SSDATA18.DAT') */
/* $INCLUDE('^/INCLUDE/SSDATA21.DAT') */
/* $INCLUDE('^/INCLUDE/SSDATA22.DAT') */
/* $INCLUDE('^/INCLUDE/SSDATA23.DAT') */
/* $INCLUDE('^/INCLUDE/SSDATA28.DAT') */
/* $INCLUDE('^/INCLUDE/SSDATA29.DAT') */
/* $INCLUDE('^/INCLUDE/SSDATA30.DAT') */
/* $INCLUDE('^/INCLUDE/SSDATA71.DAT') */
/* $INCLUDE('^/INCLUDE/SSTIMING.DAT') */
/* INITIALIZE 80x87 */
    cw87_();
/*     DETERMINE IF MIDFLIGHT RESTART */
/* $INCLUDE('SSp05.DAT') */
/*
-------------------------------------------------------------------
-----C */
/* ------------------------------ MAIN EXECUTION LOOP
--------------------C */
/*
-------------------------------------------------------------------
-----C */
/*                                Execution of all events is performed
C
*/
/*                                within this loop
C
*/
/*
C
*/
/*
-------------------------------------------------------------------
-----C */
L1000:
/*     WRITE(*,*)'--------------BEGINNING OF LOOP-----------------' */
/*
-------------------------------------------------------------------
-----C */
/* ---------------------------- MISSILE STATE UPDATE MODULE
--------------C */
/*
-------------------------------------------------------------------
-----C */
/*                              Integrate missile states to current time
C
*/
/*
C
```

```
*/
/*
-----------------------------------------------------------------
-----C */
/* --------- recieve from masspr (P00) ----------C */
    receive_real_32bit__(cg);
    receive_real_32bit__(&cg[1]);
    receive_real_32bit__(&cg[2]);
/* --------- Send variables to masspr and missil (p00)
------------------C */
    send_real_32bit__(&mdota);
    send_real_32bit__(&fxacs);
    send_real_32bit__(&fyacs);
    send_real_32bit__(&fzacs);
    send_real_32bit__(&mxacs);
    send_real_32bit__(&myacs);
    send_real_32bit__(&mzacs);
/* ---------- Communication with p01 -----------------C */
    receive_real_32bit__(&acslev);
    receive_real_32bit__(dtacsa);
    receive_real_32bit__(&dtacsa[1]);
    receive_real_32bit__(&dtacsa[2]);
    receive_real_32bit__(&dtacsa[3]);
    receive_real_32bit__(dtacsb);
    receive_real_32bit__(&dtacsb[1]);
    receive_real_32bit__(&dtacsb[2]);
    receive_real_32bit__(&dtacsb[3]);
    receive_signed_16bit__(&ithres);
    receive_real_32bit__(&tatab);
    send_signed_16bit__(&iacson);
/* ---------------------------------------------------------------
-
*/
    if (tstep >= tmsudriv) {
      tmsudriv += tmsustep;
      if (t >= tkvon) {
/*
-------------------------------------------------------
-------------C */
/* ------------------------------ ACS THRUSTER RESPONSE MODULE
-----------C */
/*
-------------------------------------------------------
-------------C */
/*                                Determines the forces and moments
      C */
/*                                imparted by the ACS thrusters
      C */
/*
      C */
/*
-------------------------------------------------------
-------------C */
          acsthr_(&t, cg, &acslev, dtacsa, dtacsb, &tatab, &toseed,
&tbrk, &
                ithres, &fxacs, &fyacs, &fzacs, &mxacs, &myacs, &mzacs,
&
                mdota, &iacson, &timona);
      }
    }
/*
-------------------------------------------------------------------
-----C */
/* ------------------------------ TERMINATION LOGIC
```

```
----------------------C */
/*
-------------------------------------------------------------------
-----C */
/*                                Defines the simulation termination
C
*/
/*                                conditions
C
*/
/*
C
*/
/*
-------------------------------------------------------------------
-----C */
/*     INITIALIZE SIMULATION EXIT FLAG TO ZERO ( PREVENTS EXIT ) */
    iexit = 0;
/*     increment time */
    tstep += (float)1.;
    t = tstep * delt;
/*     CONTINUE LOOPING UNTIL ONE OR MORE EXIT CONDITIONS HAVE BEEN MET
*/

    if (iexit == 0) {
      goto L1000;
    }
} /* MAIN__ */
```

### B.3.7 Uup06.c

```
/* uup06.f -- translated by f2c (version of 3 February 1990  3:36:42).
   You must link the resulting object file with the libraries:
      -lF77 -lI77 -lm -lc   (in that order)
*/

#include "f2c.h"

/* Table of constant values */

static shortint cs__20 = 20;

/*      PROGRAM EXOSIM */
/* ----------------------------------------------------------------------
-C */
/* ---  ----------- Declare and initialize variables  ------------------
-C */
/* ----------------------------------------------------------------------
-C */
/* Main program */ MAIN__()
{
    static real delt, mass, tmsudriv, tmsustep, t;
    static shortint iexit;
    static real tstep;
    extern /* Subroutine */ int receive_real_32bit__();
    static real masst1[20], cg[3], dt;
    extern /* Subroutine */ int send_real_32bit__();
    static shortint icg;
    static real cgx[20], cgy[20], cgz[20];
    extern /* Subroutine */ int cw87_(), sptable_();

/* DATA INITIALIZATION */
/* $INCLUDE('^/INCLUDE/SSMAS_cg.DAT') */
/* INITIALIZE 80x87 */
    cw87_();
/*       RESTARTING FROM MIDFLIGHT DATA FILE */
/* $INCLUDE('SSp06.DAT') */
/*                                                    .
-----------------------------------------------------------------
-----C */
/* ---------------------------- MAIN EXECUTION LOOP
--------------------C */
/*
-----------------------------------------------------------------
-----C */
/*                              Execution of all events is performed
C
*/
/*                              within this loop
C
*/
/*
C
*/
/*
-----------------------------------------------------------------
-----C */
L1000:
/*     WRITE(*,*)'-------------BEGINNING OF LOOP----------------' */
/*
-----------------------------------------------------------------
-----C */
```

```
/* ---------------------------- MISSILE STATE UPDATE MODULE
-------------C */
/*
-----------------------------------------------------------------
-----C */
/*                              Integrate missile states to current time
C
*/
/*
C
*/
/*
-----------------------------------------------------------------
-----C */
    if (tstep >= tmsudriv) {
      tmsudriv += tmsustep;
      dt = tmsustep * delt;
/*
-----------------------------------------------------------------
---------C */
/* ---------------------------- MASS PROPERTIES MODULE
-----------------C */
/*
-----------------------------------------------------------------
---------C */
/*                               Update cg
  C */
/*
  C */
/*
-----------------------------------------------------------------
---------C */
/*     CALCULATE MISSILE CENTER OF GRAVITY COMPONENTS */
      sptable_(masst1, cgx, &mass, cg, &cs__20, &icg);
      sptable_(masst1, cgy, &mass, &cg[1], &cs__20, &icg);
      sptable_(masst1, cgz, &mass, &cg[2], &cs__20, &icg);
    }
/*
-----------------------------------------------------------------
-----C */
/* ----------------------- Processor communication
----------------------C */
/*
-----------------------------------------------------------------
-----C */
/* ------ communication with missil model */
    receive_real_32bit__(&mass);
/* ------ send to ACSTHR and VCSTHR and ACCEL */
    send_real_32bit__(cg);
    send_real_32bit__(&cg[1]);
    send_real_32bit__(&cg[2]);
/*
-----------------------------------------------------------------
-----C */
/* ----------------------------- OUTPUT MODULE
-------------------------C */
/*
-----------------------------------------------------------------
-----C */
/*                               Creates print and plot output data
C
*/
/*                               files
C
```

```
*/
/*
C
*/
/*
-----------------------------------------------------------------
-----C */
/*      if (  mod(idnint(tstep),idnint(dtprt)).eq.0 ) then */
/*      ENDIF */
/*
-----------------------------------------------------------------
-----C */
/* ----------------------------- TERMINATION LOGIC
----------------------C */
/*
-----------------------------------------------------------------
-----C */
/*                                Defines the simulation termination
C
*/
/*                                conditions
C
*/
/*
C
*/
/*
-----------------------------------------------------------------
-----C */
/*     INITIALIZE SIMULATION EXIT FLAG TO ZERO ( PREVENTS EXIT ) */
    iexit = 0;
/*     increment time */
    tstep += (float)1.;
    t = tstep * delt;
/*     CONTINUE LOOPING UNTIL ONE OR MORE EXIT CONDITIONS HAVE BEEN MET
*/

    if (iexit == 0) {
      goto L1000;
    }
} /* MAIN__ */
```

### B.3.8 Uup07.c

```
/* uup07.f -- translated by f2c (version of 3 February 1990  3:36:42).
   You must link the resulting object file with the libraries:
      -lF77 -lI77 -lm -lc   (in that order)
*/

#include "f2c.h"

/*      PROGRAM EXOSIM */
/* ------------------------------------------------------------------
-C */
/* --------------- Declare and initialize variables  ----------------
-C */
/* ------------------------------------------------------------------
-C */
/* ------------------------------------------------------------------
-C */
/* Main program */ MAIN__()
{
    /* System generated locals */
    real r_1, r_2;

    /* Builtin functions */
    double r_nint();

    /* Local variables */
    static real tffe, delt, ttfe, rmir[3], vmir[3], vttp[3], timudriv,
          tgpudriv, dtmpl, timustep, tgpustep, t, x, y, z, dteps;
    static shortint iexit;
    static real dtcvu, tcorv, tstep;
    extern /* Subroutine */ int receive_real_32bit__();
    static real tuplk1, tuplk2, at[3], dt, vc[3], xd, vg[3], yd, zd,
vs[3],
          tfinal;
    extern /* Subroutine */ int corvel_(), send_real_32bit__();
    static real dtspvc, dlv[3];
    extern /* Subroutine */ int cw87_();
    static real ttf, mvr, mvs, vtt[3], uvs[3];

/* DATA INITIALIZATION */
/* $INCLUDE('^/INCLUDE/SSDATA35.DAT') */
/* $INCLUDE('^/INCLUDE/SSDATA38.DAT') */
/* $INCLUDE('^/INCLUDE/SSDATA39.DAT') */
/* $INCLUDE('^/INCLUDE/SSDATA42.DAT') */
/* $INCLUDE('^/INCLUDE/SSDATA44.DAT') */
/* $INCLUDE('^/INCLUDE/SSDATA45.DAT') */
/* $INCLUDE('^/INCLUDE/SSDATA46.DAT') */
/* $INCLUDE('^/INCLUDE/SSDATA47.DAT') */
/* $INCLUDE('^/INCLUDE/SSDATA48.DAT') */
/* $INCLUDE('^/INCLUDE/SSDATA49.DAT') */
/* $INCLUDE('^/INCLUDE/SSDATA50.DAT') */
/* $INCLUDE('^/INCLUDE/SSDATA01.DAT') */
/* $INCLUDE('^/INCLUDE/SSDATA17.DAT') */
/* $INCLUDE('^/INCLUDE/SSDATA18.DAT') */
/* $INCLUDE('^/INCLUDE/SSDATA21.DAT') */
/* $INCLUDE('^/INCLUDE/SSDATA22.DAT') */
/* $INCLUDE('^/INCLUDE/SSDATA23.DAT') */
/* $INCLUDE('^/INCLUDE/SSDATA28.DAT') */
/* $INCLUDE('^/INCLUDE/SSDATA29.DAT') */
/* $INCLUDE('^/INCLUDE/SSDATA30.DAT') */
/* $INCLUDE('^/INCLUDE/SSDATA71.DAT') */
/* $INCLUDE('^/INCLUDE/SSTIMING.DAT') */
```

```
/* INITIALIZE 80x87 */
    cw87_();
/* $INCLUDE('SSp07.DAT') */
/*
-----------------------------------------------------------------
-----C */
/* ----------------------------- MAIN EXECUTION LOOP
--------------------C */
/*
-----------------------------------------------------------------
-----C */
/*                                Execution of all events is performed
C
*/
/*                                within this loop
C
*/
/*
C
*/
/*
-----------------------------------------------------------------
-----C */
/*      CALL INITIALIZE_TIMING() */
L1000:
/*      CALL START_TIMING(0) */
/*     WRITE(*,*)'-------------BEGINNING OF LOOP-----------------' */
/*
-----------------------------------------------------------------
-----C */
/* ------------------------ Processor communication
----------------------C */
/*
-----------------------------------------------------------------
-----C */
/*      CALL SWITCH_TIMING() */
/* ----------------------- COMMUNICATION WITH P00
-----------------------C */
    receive_real_32bit__(&x);
    receive_real_32bit__(&y);
    receive_real_32bit__(&z);
    receive_real_32bit__(&xd);
    receive_real_32bit__(&yd);
    receive_real_32bit__(&zd);
    receive_real_32bit__(rmir);
    receive_real_32bit__(&rmir[1]);
    receive_real_32bit__(&rmir[2]);
    receive_real_32bit__(vmir);
    receive_real_32bit__(&vmir[1]);
    receive_real_32bit__(&vmir[2]);
/* ----------------------- COMMUNICATION WITH P01
-----------------------C */
    receive_real_32bit__(at);
    receive_real_32bit__(&at[1]);
    receive_real_32bit__(&at[2]);
    send_real_32bit__(vg);
    send_real_32bit__(&vg[1]);
    send_real_32bit__(&vg[2]);
/*      CALL SWITCH_TIMING() */
/*
-----------------------------------------------------------------
-----C */
/* ----------------------------- INERTIAL MEASUREMENT UPDATE
------------C */
```

```
/*
-----------------------------------------------------------------
-----C */
/*                              Get inertial measurement data needed
C
*/
/*                              for guidance calculations .
C
*/
/*
C
*/
/*
-----------------------------------------------------------------
-----C */
    if (tstep >= timudriv) {
      timudriv += timustep;
/*        TIME SINCE LAST INERTIAL MEASUREMENT UPDATE */
      dt = timustep * delt;
/*        INTEGRATE GRAVITY COMPENSATED ACCELERATION */
      vtt[0] += dt * at[0];
      vtt[1] += dt * at[1];
      vtt[2] += dt * at[2];
    }
/*
-----------------------------------------------------------------
-----C */
/* ----------------------------- MIDCOURSE CORRECTION
-------------------C */
/*
-----------------------------------------------------------------
-----C */
/*                              Models uplink of interceptor,
C
*/
/*                              target, and intercept conditions
C
*/
/*
C
*/
/*
-----------------------------------------------------------------
-----C */
    if ((r_1 = t - tuplk1, dabs(r_1)) <= dteps || (r_2 = t - tuplk2,
dabs(r_2)
         ) <= dteps) {
/*        REVISE ESTIMATED MISSILE STATES */
      vmir[0] = xd;
      vmir[1] = yd;
      vmir[2] = zd;
      rmir[0] = x;
      rmir[1] = y;
      rmir[2] = z;
    }
/*
-----------------------------------------------------------------
-----C */
/*                              ON BOARD GUIDANCE PROCESSING
C
*/
/*
-----------------------------------------------------------------
-----C */
```

```
/*                              Determine guidance commands
C
*/
/*
C
*/
/*
-------------------------------------------------------------------
-----C */
    if (tstep >= tgpudriv) {
      tgpudriv += tgpustep;
/*
-----------------------------------------------------------------
---------C */
/* ----------------------------- CORRELATED VELOCITY MODULE
-------------C */
/*
-----------------------------------------------------------------
---------C */
/*                              This section calculates the
correlated  C */
/*                              velocity vector (VC) through an iter-
  C */
/*                              ative process.  From VC, the steering
  C */
/*                              velocity vector is produced by sub-
  C */
/*                              tracting a bias velocity (VD0) from
the C */
/*                              velocity to be gained (VG).
  C */
/*
  C */
/*
-----------------------------------------------------------------
---------C */
      if (t >= tcorv && t <=    f - dtspvc) {
          corvel_(&t, &mvr, vtt, rmir, vmir, vttp, vg, vs, &mvs, uvs,
vc,
                dlv, &tffe, &ttfe);
          r_1 = (t + dtcvu) / dtcvu;
          dtmp1 = dtcvu * r_nint(&r_1);
          tcorv = dtmp1;
      }
    }
/*
-------------------------------------------------------------------
-----C */
/* ----------------------------- OUTPUT MODULE
-------------------------C */
/*
-------------------------------------------------------------------
-----C */
/*          call stop_timing() */
/*       if ( mod(int(tstep),int(dtprt)).eq.0 ) then */
/*          call output_timing() */
/*          call INITIALIZE_TIMING() */
/*       ENDIF */
/*
-------------------------------------------------------------------
-----C */
/* ---------------------------- TERMINATION LOGIC
---------------------C */
/*
```

```
------------------------------------------------------------------
-----C */
/*                              Defines the simulation termination
C
*/
/*                              conditions
C
*/
/*
C
*/
/*
------------------------------------------------------------------
-----C */
/*     INITIALIZE SIMULATION EXIT FLAG TO ZERO ( PREVENTS EXIT ) */
    iexit = 0;
/*     ENABLE EXIT IF MAXIMUM SIMULATION TIME HAS BEEN EXECUTED AND ALL
*/

/*     EVENTS SCHEDULED FOR THIS TIME HAVE BEEN EXECUTED */
    if (t >= tfinal) {
      iexit = 1;
    }
/*     increment time */
    tstep += 1.;
    t = tstep * delt;
/*     CONTINUE LOOPING UNTIL ONE OR MORE EXIT CONDITIONS HAVE BEEN MET
*/

    if (iexit == 0) {
      goto L1000;
    }
} /* MAIN__ */
```

### B.3.9 Uup08.c

```
/* uup08.f -- translated by f2c (version of 3 February 1990  3:36:42).
   You must link the resulting object file with the libraries:
      -lF77 -lI77 -lm -lc   (in that order)
*/

#include "f2c.h"

/* Common Block Declarations */

struct {
    doublereal xint[50], tint[50], xdotl[50];
} storag_;

#define storag_1 storag_

struct {
    doublereal xyzlch[3];
} rmissl_;

#define rmissl_1 rmissl_

/* Table of constant values */

static shortint cs__6 = 6;
static shortint cs__7 = 7;
static shortint cs__8 = 8;
static shortint cs__9 = 9;
static shortint cs__10 = 10;
static shortint cs__11 = 11;
static doublereal c_b8 = 0.;
static shortint cs__1 = 1;
static shortint cs__2 = 2;
static shortint cs__3 = 3;
static integer c__1 = 1;

/*      PROGRAM EXOSIM */
/* ----------------------------------------------------------------------
-C */
/* --------------- Declare and initialize variables  ------------------
-C */
/* ----------------------------------------------------------------------
-C */
/* ----------------------------------------------------------------------
-C */
/* Main program */ MAIN__()
{

    /* Format strings */
    static char fmt_202[] = "(1x,f8.4,4e14.7)";

    /* System generated locals */
    real r_1;
    doublereal d_1, d_2, d_3;

    /* Builtin functions */
    double sqrt(), atan2();
    integer s_wsfi(), do_fio(), e_wsfi();

    /* Local variables */
    static doublereal rade, delt, long_, mass, xyze[3], xyzr[3],
tmsudriv,
```

```
        tmsustep, t, x, y;
    static real s_cim__[9];
    static doublereal z, xyzed[3], tstep, fxacs, fxvcs, fyacs, fyvcs,
fzacs,
        fzvcs;
    extern /* Subroutine */ int integ_();
    static doublereal tlmsu;
    extern /* Subroutine */ int receive_real_32bit__();
    static doublereal dtprt;
    static shortint iexit;
    static doublereal gb[3], gr[3];
    static real s_mass__;
    static doublereal mxyzdd, xyzedd[3];
    extern /* Subroutine */ int missil_();
    static shortint nclear;
    static doublereal ud, vd, wd, fx, cie[9], fy, fz, xd, yd, zd,
cim[9], cer[
        9], cir[9], lat, mgr, cri[9];
    static char message[128];
    static real s_fxacs__, s_fyacs__, s_fzacs__, s_fxvcs__, s_fyvcs__,
        s_fzvcs__;
    extern /* Subroutine */ int cw87_();
    static doublereal xdd, ydd, zdd;
    extern /* Subroutine */ int mmk_();
    static doublereal omegae, dtr, alt;
    extern /* Subroutine */ int send_real_32bit__(),
send_real_64bit__();
    static shortint iprint;
    extern /* Subroutine */ int outmes_();
    static doublereal tfinal;

    /* Fortran I/O blocks */
    static icilist io__63 = { 0, message, 0, fmt_202, 128, 1 };


/*     THE FOLLOWING COMMON BLOCKS USED FOR MIDFLIGHT CAPABILITIES ONLY
*/

/*     OUTPUTS */
/*     NAMELIST INPUTS */
/* DATA INITIALIZATION */
/* $INCLUDE('^/INCLUDE/SSDATA35.DAT') */
/* $INCLUDE('^/INCLUDE/SSDATA38.DAT') */
/* $INCLUDE('^/INCLUDE/SSDATA39.DAT') */
/* $INCLUDE('^/INCLUDE/SSDATA42.DAT') */
/* $INCLUDE('^/INCLUDE/SSDATA44.DAT') */
/* $INCLUDE('^/INCLUDE/SSDATA45.DAT') */
/* $INCLUDE('^/INCLUDE/SSDATA46.DAT') */
/* $INCLUDE('^/INCLUDE/SSDATA47.DAT') */
/* $INCLUDE('^/INCLUDE/SSDATA48.DAT') */
/* $INCLUDF('^/INCLUDE/SSDATA49.DAT') */
/* $INCLUDE('^/INCLUDE/SSDATA50.DAT') */
/* $INCLUDE('^/INCLUDE/SSDATA01.DAT') */
/* $INCLUDE('^/INCLUDE/SSDATA17.DAT') */
/* $INCLUDE('^/INCLUDE/SSDATA18.DAT') */
/* $INCLUDE('^/INCLUDE/SSDATA21.DAT') */
/* $INCLUDE('^/INCLUDE/SSDATA22.DAT') */
/* $INCLUDE('^/INCLUDE/SSDATA23.DAT') */
/* $INCLUDE('^/INCLUDE/SSDATA28.DAT') */
/* $INCLUDE('^/INCLUDE/SSDATA29.DAT') */
/* $INCLUDE('^/INCLUDE/SSDATA30.DAT') */
/* $INCLUDE('^/INCLUDE/SSDATA71.DAT') */
/* $INCLUDE('^/INCLUDE/SSTIMING.DAT') */
/* $INCLUDE('^/INCLUDE/SSMAS_cg.DAT') */
```

```
/* INITIALIZE 80x87 */
    cw87_();
/* $INCLUDE('SSp08.DAT') */
/*
-----------------------------------------------------------------
-----C */
/* ----------------------------- MAIN EXECUTION LOOP
--------------------C */
/*
-----------------------------------------------------------------
-----C */
/*                                Execution of all events is performed
C
*/
/*                                within this loop
C
*/
/*
C
*/
/*
-----------------------------------------------------------------
-----C */
L1000:
/*     WRITE(*,*)'--------------BEGINNING OF LOOP-----------------' */
/*
-----------------------------------------------------------------
-----C */
/* ---------------------------- MISSILE STATE UPDATE MODULE
--------------C */
/*
-----------------------------------------------------------------
-----C */
/*                              Integrate missile states to current time
C
*/
/*
C
*/
/*
-----------------------------------------------------------------
-----C */
    if (tstep >= tmsudriv) {
      tmsudriv += tmsustep;
/*
-----------------------------------------------------------------
---------C */
/* ----------------------------- VEHICLE STATES MODULE
------------------C */
/*
-----------------------------------------------------------------
---------C */
/*                                Compute missile state derivatives
  C */
/*
  C */
/*
-----------------------------------------------------------------
---------C */
      missil_(&t, cim, &mass, &fxacs, &fxvcs, &fyacs, &fyvcs, &fzacs, &
            fzvcs, &x, &y, &z, &nclear, &ud, &vd, &wd, gb, gr, &mgr,
&fx,
            &fy, &fz, &xdd, &ydd, &zdd, &mxyzdd);
/*
```

```
------------------------------------------------------------
---------C */
/*                              MISSILE STATE INTEGRATION MODULE
  C */
/*
------------------------------------------------------------
---------C */
/*                              Revise missile states using
derivatives C */
/*                              just computed . Missile states must
not C */
/*                              be integrated if a table lookup index
  C */
/*                              transition has occurred since the
last  C */
/*                              integration step . The next
integration C */
/*                              step should be rescheduled to
coincide  C */
/*                              with the earliest detected table
lookup C */
/*                              index transition instead . Otherwise
  C */
/*                              schedule the next integration step to
  C */
/*                              occur at the default step size .
  C */
/*
  C */
/*
------------------------------------------------------------
---------C */
/*        TRAPEZOIDAL INTEGRATION FOR SIMPLICITY */
      integ_(&xd, &xdd, &t, &cs__6);
      integ_(&yd, &ydd, &t, &cs__7);
      integ_(&zd, &zdd, &t, &cs__8);
      integ_(&x, &xd, &t, &cs__9);
      integ_(&y, &yd, &t, &cs__10);
      integ_(&z, &zd, &t, &cs__11);
/*        TRANSFORM INERTIAL POSITION AND VELOCITY TO EARTH FRAME */
      xyze[0] = cie[0] * x + cie[3] * y + cie[6] * z;
      xyze[1] = cie[1] * x + cie[4] * y + cie[7] * z;
      xyze[2] = cie[2] * x + cie[5] * y + cie[8] * z;
      xyzed[0] = cie[0] * xd + cie[3] * yd + cie[6] * zd;
      xyzed[1] = cie[1] * xd + cie[4] * yd + cie[7] * zd;
      xyzed[2] = cie[2] * xd + cie[5] * yd + cie[8] * zd;
      xyzedd[0] = cie[0] * xdd + cie[3] * ydd + cie[6] * zdd;
      xyzedd[1] = cie[1] * xdd + cie[4] * ydd + cie[7] * zdd;
      xyzedd[2] = cie[2] * xdd + cie[5] * ydd + cie[8] * zdd;
/*        ROTATING EARTH MODEL */
      d_1 = omegae * t;
      mmk_(&c_b8, &cs__1, &c_b8, &cs__2, &d_1, &cs__3, cer);
      xyzr[0] = cer[0] * xyze[0] + cer[3] * xyze[1] + cer[6] * xyze[2];
      xyzr[1] = cer[1] * xyze[0] + cer[4] * xyze[1] + cer[7] * xyze[2];
      xyzr[2] = cer[2] * xyze[0] + cer[5] * xyze[1] + cer[8] * xyze[2];
      cir[0] = cer[0] * cie[0] + cer[3] * cie[1] + cer[6] * cie[2];
      cir[1] = cer[1] * cie[0] + cer[4] * cie[1] + cer[7] * cie[2];
      cir[2] = cer[2] * cie[0] + cer[5] * cie[1] + cer[8] * cie[2];
      cir[3] = cer[0] * cie[3] + cer[3] * cie[4] + cer[6] * cie[5];
      cir[4] = cer[1] * cie[3] + cer[4] * cie[4] + cer[7] * cie[5];
      cir[5] = cer[2] * cie[3] + cer[5] * cie[4] + cer[8] * cie[5];
      cir[6] = cer[0] * cie[6] + cer[3] * cie[7] + cer[6] * cie[8];
      cir[7] = cer[1] * cie[6] + cer[4] * cie[7] + cer[7] * cie[8];
      cir[8] = cer[2] * cie[6] + cer[5] * cie[7] + cer[8] * cie[8];
```

```
      cri[0] = cir[0];
      cri[1] = cir[3];
      cri[2] = cir[6];
      cri[3] = cir[1];
      cri[4] = cir[4];
      cri[5] = cir[7];
      cri[6] = cir[2];
      cri[7] = cir[5];
      cri[8] = cir[8];
/*        CALCULATE CURRENT LATITUDE AND LONGITUDE */
/* Computing 2nd power */
      d_1 = xyzr[0];
/* Computing 2nd power */
      d_2 = xyzr[1];
      lat = atan2(xyzr[2], (sqrt(d_1 * d_1 + d_2 * d_2))) / dtr;
      long_ = atan2(xyzr[1], xyzr[0]) / dtr;
/*        CALCULATE CURRENT MISSILE ALTITUDE */
/* Computing 2nd power */
      d_1 = x;
/* Computing 2nd power */
      d_2 = y;
/* Computing 2nd power */
      d_3 = z;
      alt = sqrt(d_1 * d_1 + d_2 * d_2 + d_3 * d_3) - rade;
/*        SAVE TIME OF LAST MISSILE STATE UPDATE */
      tlmsu = t;
    }
/*
-----------------------------------------------------------------
-----C */
/* ------------------------ Processor communication
----------------------C */
/*
-----------------------------------------------------------------
-----C */
/* ---------  Communicate with p01  -----------C */
    r_1 = gr[0];
    send_real_32bit__(&r_1);
    r_1 = gr[1];
    send_real_32bit__(&r_1);
    r_1 = gr[2];
    send_real_32bit__(&r_1);
    receive_real_32bit__(&s_mass__);
    mass = s_mass__;
    send_real_64bit__(xyze);
    send_real_64bit__(&xyze[1]);
    send_real_64bit__(&xyze[2]);
    send_real_64bit__(xyzed);
    send_real_64bit__(&xyzed[1]);
    send_real_64bit__(&xyzed[2]);
/* -------------  Communicate with p03 -------------------------------C
*/
    send_real_64bit__(&x);
    send_real_64bit__(&y);
    send_real_64bit__(&z);
    r_1 = x;
    send_real_32bit__(&r_1);
    r_1 = y;
    send_real_32bit__(&r_1);
    r_1 = z;
    send_real_32bit__(&r_1);
    r_1 = xd;
    send_real_32bit__(&r_1);
    r_1 = yd;
```

```
    send_real_32bit__(&r_1);
    r_1 = zd;
    send_real_32bit__(&r_1);
    receive_real_32bit__(s_cim__);
    receive_real_32bit__(&s_cim__[1]);
    receive_real_32bit__(&s_cim__[2]);
    receive_real_32bit__(&s_cim__[3]);
    receive_real_32bit__(&s_cim__[4]);
    receive_real_32bit__(&s_cim__[5]);
    receive_real_32bit__(&s_cim__[6]);
    receive_real_32bit__(&s_cim__[7]);
    receive_real_32bit__(&s_cim__[8]);
    cim[0] = s_cim__[0];
    cim[1] = s_cim__[1];
    cim[2] = s_cim__[2];
    cim[3] = s_cim__[3];
    cim[4] = s_cim__[4];
    cim[5] = s_cim__[5];
    cim[6] = s_cim__[6];
    cim[7] = s_cim__[7];
    cim[8] = s_cim__[8];
/* ---------  Receive from ACSTHR and VCSTHR  -----------C */
    receive_real_32bit__(&s_fxvcs__);
    receive_real_32bit__(&s_fyvcs__);
    receive_real_32bit__(&s_fzvcs__);
    receive_real_32bit__(&s_fxacs__);
    receive_real_32bit__(&s_fyacs__);
    receive_real_32bit__(&s_fzacs__);
    fxvcs = s_fxvcs__;
    fyvcs = s_fyvcs__;
    fzvcs = s_fzvcs__;
    fxacs = s_fxacs__;
    fyacs = s_fyacs__;
    fzacs = s_fzacs__;
    r_1 = ud;
    send_real_32bit__(&r_1);
    r_1 = vd;
    send_real_32bit__(&r_1);
    r_1 = wd;
    send_real_32bit__(&r_1);
/*
-------------------------------------------------------------------
-----C */
/* ---------------------------- OUTPUT MODULE
-------------------------C */
/*
-------------------------------------------------------------------
-----C */
/*                                Creates print and plot output data
C
*/
/*                                files
C
*/
/*
C
*/
/*
-------------------------------------------------------------------
-----C */
    ++iprint;
    if (iprint == (shortint) dtprt) {
      s_wsfi(&io__63);
      do_fio(&c__1, (char *)&t, (ftnlen)sizeof(doublereal));
```

```
      do_fio(&c__1, (char *)&alt, (ftnlen)sizeof(doublereal));
      do_fio(&c__1, (char *)&x, (ftnlen)sizeof(doublereal));
      do_fio(&c__1, (char *)&y, (ftnlen)sizeof(doublereal));
      do_fio(&c__1, (char *)&z, (ftnlen)sizeof(doublereal));
      e_wsfi();
      outmes_(message, 128L);
      iprint = 0;
    }
/*
-----------------------------------------------------------------
-----C */
/* ---------------------------- TERMINATION LOGIC
----------------------C */
/*
-----------------------------------------------------------------
-----C */
/*                                Defines the simulation termination
C
*/
/*                                conditions
C
*/
/*
C
*/
/*
-------------------------------------------------- ------------
-----C */
/*     INITIALIZE SIMULATION EXIT FLAG TO ZERO ( PREVENTS EXIT ) */
    iexit = 0;
/*     ENABLE EXIT IF MAXIMUM SIMULATION TIME HAS BEEN EXECUTED AND ALL
*/

/*     EVENTS SCHEDULED FOR THIS TIME HAVE BEEN EXECUTED */
    if (t >= tfinal) {
      iexit = 1;
    }
/*     ENABLE EXIT IF MISSILE HAS IMPACTED AND ALL EVENTS SCHEDULED FOR
*/

/*     THIS TIME HAVE BEEN EXECUTED */
    if (alt < 0.) {
      iexit = 1;
    }
/*     increment time */
    tstep += 1.;
    t = tstep * delt;
/*     CONTINUE LOOPING UNTIL ONE OR MORE EXIT CONDITIONS HAVE BEEN MET
*/

    if (iexit == 0) {
      goto L1000;
    }
    outmes_("ERROR: Exit from P08", 20L);
} /* MAIN__ */
```

### B.3.10 Uup09.c

```
/* uup09.f -- translated by f2c (version of 3 February 1990  3:36:42).
   You must link the resulting object file with the libraries:
      -lF77 -lI77 -lm -lc   (in that order)
*/

#include "f2c.h"

/* Common Block Declarations */

struct {
    real gset;
    shortint iset;
} norcom_;

#define norcom_1 norcom_

struct {
    real ranseq[97], ranlst;
} rancom_;

#define rancom_1 rancom_

/*      PROGRAM EXOSIM */
/* ----------------------------------------------------------------------
-C */
/* --------------- Declare and initialize variables  -------------------
-C */
/* ----------------------------------------------------------------------
-C */
/* Main program */ MAIN__()
{
    static shortint acqd;
    static real lamm[2], delt;
    static shortint term;
    static real tspudriv, t;
    static shortint track, iexit;
    static real tstep;
    extern /* Subroutine */ int receive_real_32bit__();
    static real lamsek[2];
    static integer skseed;
    extern /* Subroutine */ int seeker_();
    static real samrat;
    static shortint frmcnt,
    static real frmrat, magrtr;
    extern /* Subroutine */ int send_real_32bit__(), cw87_();
    static real snr;

/* $INCLUDE(':pfp:INCLUDE/target.for') */
/* INITIALIZE 80x87 */
    cw87_();
/* $INCLUDE('ssp09.dat') */
/*
-----------------------------------------------------------------
-----C */
/* ----------------------------- MAIN EXECUTION LOOP
 ------------------C */
/*
-----------------------------------------------------------------
-----C */
/*                                Execution of all events is performed
C
```

```
*/
/*                                 within this loop
C
*/
/*
C
*/
/*
-----------------------------------------------------------------
-----C */
/*     CALL INITIALIZE_TIMING() */
L1000:
/*     call reset_timer() */
/*      timer = read_timer() */
/*     CALL START_TIMING(0) */
/*     WRITE(*,*)'--------------BEGINNING OF LOOP-----------------' */
/*
-----------------------------------------------------------------
-----C */
/* ----------------------- Processor communication
---------------------C */
/*
-----------------------------------------------------------------
-----C */
/*     CALL SWITCH_TIMING() */
/* ---------------------- COMMUNICATION WITH KALMAN
--------------------C */
    send_real_32bit__(lamm);
    send_real_32bit__(&lamm[1]);
    send_real_32bit__(&snr);
    send_real_32bit__(&frmrat);
/* ---------------------- COMMUNICATION WITH RELAT
--------------------C */
    receive_real_32bit__(lamsek);
    receive_real_32bit__(&lamsek[1]);
    receive_real_32bit__(&magrtr);
/*     CALL SWITCH_TIMING() */
/*
-----------------------------------------------------------------
-----C */
/* --------------------------- SEEKER MODULE
-------------------------C */
/*
-----------------------------------------------------------------
-----C */
/*                                 Calculates LOS angles measured by the
C
*/
/*                                 seeker
C
*/
/*
C
*/
/*
-----------------------------------------------------------------
-----C */
    if (tstep >= tspudriv) {
/*         TSPUDRIV = TSPUDRIV + TSPUSTEP */
      seeker_(&t, &acqd, lamsek, &magrtr, &skseed, &frmrat, &frmcnt, &
            samrat, &track, &term, &snr, lamm);
      tspudriv += (shortint) ((float)1e3 / frmrat);
    }
/*     delt_time = (timer -(read_timer() + 18))/1.229e6 */
```

```
/*     CALL output_message( %VAL(real_32bit), delt_time, */
/*    &     %VAL(int2(1)) ) */
/*     call output_nl */
/*
-----------------------------------------------------------------
-----C */
/* ---------------------------- OUTPUT MODULE
--------------------------C */
/*
-----------------------------------------------------------------
-----C */
/*        call stop_timing() */
/*     if (  mod(idnint(tstep),idnint(dtprt)).eq.0 ) then */
/*        call output_timing() */
/*        call INITIALIZE_TIMING() */
/*     ENDIF */
/*
-----------------------------------------------------------------
-----C */
/* ---------------------------- TERMINATION LOGIC
----------------------C */
/*
-----------------------------------------------------------------
-----C */
/*                                Defines the simulation termination
C
*/
/*                                conditions
C
*/
/*
C
*/
/*
-----------------------------------------------------------------
-----C */
/*     INITIALIZE SIMULATION EXIT FLAG TO ZERO ( PREVENTS EXIT ) */
    iexit = 0;
/*     increment time */
    tstep += (float)1.;
    t = tstep * delt;
/*     CONTINUE LOOPING UNTIL ONE OR MORE EXIT CONDITIONS HAVE BEEN MET
*/

    if (iexit == 0) {
      goto L1000;
    }
} /* MAIN__ */
```

## B.3.11 Uup10.c

```
/* uup10.f -- translated by f2c (version of 3 February 1990  3:36:42).
   You must link the resulting object file with the libraries:
      -lF77 -lI77 -lm -lc   (in that order)
*/

#include "f2c.h"

/* Common Block Declarations */

struct {
    doublereal gset;
    shortint iset;
} norcom_;

#define norcom_1 norcom_

struct {
    real ranseq[97], ranlst;
} rancom_;

#define rancom_1 rancom_

struct {
    doublereal drsiga, psia, thta, phia, thxza, thxya, thyza, thyxa,
thzya,
          thzxa, sf1a[3], sf2a[3], dca[3], t0acce, grlst[3], xyzdp[3],
abi2[
          3], abi1[3], abo2[3], abo1[3];
} raccel_;

#define raccel_1 raccel_

/*     PROGRAM EXOSIM */
/* ----------------------------------------------------------------------
-C */
/* --------------- Declare and initialize variables  -------------------
-C */
/* ----------------------------------------------------------------------
-C */
/* Main program */ MAIN__()
{
    /* System generated locals */
    real r_1;

    /* Local variables */
    static real s_cg__[3], s_pd__, s_qd__, s_rd__;
    static doublereal delt;
    static real s_ud__, s_vd__, s_wd__, s_xd__, s_yd__, s_zd__,
s_gr__[3];
    static doublereal timudriv, timustep;
    extern /* Subroutine */ int accel_();
    static doublereal p, q, r, t;
    static real s_cim__[9];
    static shortint iexit;
    static doublereal tstep;
    extern /* Subroutine */ int receive_real_32bit__();
    static doublereal cg[3], pd, qd, rd, gr[3], ud, vd, xd, qfraca[3],
yd, zd,
          wd;
    static integer gyseed;
    static doublereal pulsea[3];
```

```
    extern /* Subroutine */ int send_real_32bit__();
    static doublereal cim[9];
    static real s_p__, s_q__, s_r__;
    extern /* Subroutine */ int cw87_();

/*     THE FOLLOWING COMMON BLOCKS USED FOR MIDFLIGHT CAPABILITIES ONLY
*/

/* DATA INITIALIZATION */
/* $include ('^/include/ssdata35.dat') */
/* $include ('^/include/ssdata38.dat') */
/* $include ('^/include/ssdata39.dat') */
/* $include ('^/include/ssdata42.dat') */
/* $include ('^/include/ssdata44.dat') */
/* $include ('^/include/ssdata45.dat') */
/* $include ('^/include/ssdata46.dat') */
/* $include ('^/include/ssdata47.dat') */
/* $include ('^/include/ssdata48.dat') */
/* $include ('^/include/ssdata49.dat') */
/* $include ('^/include/ssdata50.dat') */
/* $include ('^/include/ssdata01.dat') */
/* $include ('^/include/ssdata17.dat') */
/* $include ('^/include/ssdata18.dat') */
/* $include ('^/include/ssdata21.dat') */
/* $include ('^/include/ssdata22.dat') */
/* $include ('^/include/ssdata23.dat') */
/* $include ('^/include/ssdata28.dat') */
/* $include ('^/include/ssdata29.dat') */
/* $include ('^/include/ssdata30.dat') */
/* $include ('^/include/ssdata71.dat') */
/* $include ('^/include/sstiming.dat') */
    cw87_();
/* $include ('ssp10.dat') */
/*
-----------------------------------------------------------------
-----C */
/* ----------------------------- MAIN EXECUTION LOOP
---------------------C */
/*
-----------------------------------------------------------------
-----C */
/*                                Execution of all events is performed
C
*/
/*                                within this loop
C
*/
/*
C
*/
/*
-----------------------------------------------------------------
-----C */
L1000:
/*     WRITE(*,*)'--------------BEGINNING OF LOOP-----------------' */
/*
-----------------------------------------------------------------
-----C */
/* ----------------------- Processor communication
----------------------C */
/*
-----------------------------------------------------------------
-----C */
/* ----------------  ---  Communicate with p01
```

```
-----------------------------C */
    receive_real_32bit__(s_gr__);
    receive_real_32bit__(&s_gr__[1]);
    receive_real_32bit__(&s_gr__[2]);
    gr[0] = (doublereal) s_gr__[0];
    gr[1] = (doublereal) s_gr__[1];
    gr[2] = (doublereal) s_gr__[2];
    r_1 = pulsea[0];
    send_real_32bit__(&r_1);
    r_1 = pulsea[1];
    send_real_32bit__(&r_1);
    r_1 = pulsea[2];
    send_real_32bit__(&r_1);
    receive_real_32bit__(s_cg__);
    receive_real_32bit__(&s_cg__[1]);
    receive_real_32bit__(&s_cg__[2]);
    cg[0] = (doublereal) s_cg__[0];
    cg[1] = (doublereal) s_cg__[1];
    cg[2] = (doublereal) s_cg__[2];
    receive_real_32bit__(&s_p__);
    receive_real_32bit__(&s_q__);
    receive_real_32bit__(&s_r__);
    p = (doublereal) s_p__;
    q = (doublereal) s_q__;
    r = (doublereal) s_r__;
    receive_real_32bit__(&s_xd__);
    receive_real_32bit__(&s_yd__);
    receive_real_32bit__(&s_zd__);
    xd = (doublereal) s_xd__;
    yd = (doublereal) s_yd__;
    zd = (doublereal) s_zd__;
    receive_real_32bit__(s_cim__);
    receive_real_32bit__(&s_cim__[1]);
    receive_real_32bit__(&s_cim__[2]);
    receive_real_32bit__(&s_cim__[3]);
    receive_real_32bit__(&s_cim__[4]);
    receive_real_32bit__(&s_cim__[5]);
    receive_real_32bit__(&s_cim__[6]);
    receive_real_32bit__(&s_cim__[7]);
    receive_real_32bit__(&s_cim__[8]);
    cim[0] = (doublereal) s_cim__[0];
    cim[1] = (doublereal) s_cim__[1];
    cim[2] = (doublereal) s_cim__[2];
    cim[3] = (doublereal) s_cim__[3];
    cim[4] = (doublereal) s_cim__[4];
    cim[5] = (doublereal) s_cim__[5];
    cim[6] = (doublereal) s_cim__[6];
    cim[7] = (doublereal) s_cim__[7];
    cim[8] = (doublereal) s_cim__[8];
    receive_real_32bit__(&s_pd__);
    receive_real_32bit__(&s_qd__);
    receive_real_32bit__(&s_rd__);
    receive_real_32bit__(&s_ud__);
    receive_real_32bit__(&s_vd__);
    receive_real_32bit__(&s_wd__);
    pd = (doublereal) s_pd__;
    qd = (doublereal) s_qd__;
    rd = (doublereal) s_rd__;
    ud = (doublereal) s_ud__;
    vd = (doublereal) s_vd__;
    wd = (doublereal) s_wd__;
/*
-----------------------------------------------------------------
-----C */
```

```
/* ------------------------------ INERTIAL MEASUREMENT UPDATE
------------C */
/*
-------------------------------------------------------------------
-----C */
/*                                Get inertial measurement data needed
C
*/
/*                                for guidance calculations .
C
*/
/*
C
*/
/*
-------------------------------------------------------------------
-----C */
    if (tstep >= timudriv) {
      timudriv += timustep;
/*
-----------------------------------------------------------
---------C */
/* ------------------------------ ACCELEROMETER MODULE
--------------------C */
/*
-----------------------------------------------------------
---------C */
/*                                Determine sensed accelerations
  C */
/*
  C */
/*
-----------------------------------------------------------
---------C */
      accel_(&t, &ud, &vd, &wd, &p, &q, &r, &pd, &qd, &rd, cg, cim, &xd,
&
            yd, &zd, gr, &gyseed, qfraca, pulsea);
    }
/*
-------------------------------------------------------------------
-----C */
/* ------------------------------ TERMINATION LOGIC
----------------------C */
/*
-------------------------------------------------------------------
-----C */
/*                                Defines the simulation termination
C
*/
/*                                conditions
C
*/
/*
C
*/
/*
-------------------------------------------------------------------
-----C */
/*     INITIALIZE SIMULATION EXIT FLAG TO ZERO ( PREVENTS EXIT ) */
    iexit = 0;
/*     increment time */
    tstep += 1.;
    t = tstep * delt;
```

```
/*      CONTINUE LOOPING UNTIL ONE OR MORE EXIT CONDITIONS HAVE BEEN MET
*/

    if (iexit == 0) {
      goto L1000;
    }
} /* MAIN__ */
```

## B.3.12 Uup11.c

```
/* uup11.f -- translated by f2c (version of 3 February 1990  3:36:42).
   You must link the resulting object file with the libraries:
      -lF77 -lI77 -lm -lc   (in that order)
*/

#include "f2c.h"

/* Common Block Declarations */

struct {
    shortint iseq[4];
    real tvcomp, omega0[3];
    shortint imidb2;
    real tmidb2;
    shortint isk3on;
} rmguid_;

#define rmguid_1 rmguid_

struct {
    real angacl[120]    /* was [3][4][10] */;
    shortint imcpas[12] /* was [3][4] */;
    real tp2end, tp3end;
    shortint ip2end;
    real tcoast;
    shortint icoast;
    real trdone;
    shortint irate, iacsb1, iacsb2, icnt, ivpf1, ivpfln;
    real tburn2, omegai[3], tlstma, aaccel[12]  /* was [3][4] */;
} rmauto_;

#define rmauto_1 rmauto_

struct {
    real sw17, sw18, sw18p, sw18y, sw19, sw19p, sw19y;
    shortint iroll;
    real tpton2, tyton2, tnextp, tnexty, fltcp1, fltcy1;
} rkvaut_;

#define rkvaut_1 rkvaut_

/* Table of constant values */

static shortint cs__0 = 0;
static shortint cs__1 = 1;

/*      PROGRAM EXOSIM */
/* ----------------------------------------------------------------------
-C */
/* --------------- Declare and initialize variables  -------------------
-C */
/* ----------------------------------------------------------------------
-C */
/* Main program */ MAIN__()
{
    /* System generated locals */
    real r_1;

    /* Local variables */
    static shortint acqd, icmd;
    static real lamd[2], magr, delt, fltc[4];
```

```
    static shortint flip;
    static real magv;
    static shortint igit;
    static real tsah, dtacsa_s__[4], dtacsb_s__[4], mass, rrel[3],
vrel[3],
          tsal, anvp, acslev_s__;
    static shortint ivcs;
    static real tgil, dtoffv_s__[4], tofflt_s__[4];
    static shortint ithres_s__;
    extern /* Subroutine */ int send_signed_16bit__();
    static real tburnm_s__, tapudriv, timonv_s__, tgpudriv, tapustep,
tgilp,
          tgi2p, tgi3p, tgpustep, tgily, tgi2y, tgi3y, tstg2, t, tatab;
    static shortint ivtab;
    static real fltcp;
    static shortint idist, idrop;
    static real dteps, tvtab, piter, tlaps, fltcy;
    static shortint iexit;
    static real yawer, tdrop, urrel[3], tstep;
    extern /* Subroutine */ int receive_real_32bit__();
    static real tkvon, tnext, tge2al;
    static shortint iburn1, iburn2, iburn3;
    static real vg[3], dtacsa[4], dtacsb[4], sp, sq, sr;
    static shortint idmeas, imcend;
    extern /* Subroutine */ int mcguid_();
    static shortint midbrn, iacson;
    static real acslev, tfinal;
    static shortint estate, iburnd, ivcs_s__;
    static real adistt[12]    /* was [4][3] */, dtoffv[4], mgrdot,
dtvcsp[3]
          , tofflt[4];
    extern /* Subroutine */ int mcauto_();
    static real roller, dtvcsy[3];
    static shortint iburnm, ipassm;
    static real traton, tpaton, tyaton, dtsamp;
    static shortint ithres;
    static real tmauto, tburnm, timonv;
    extern /* Subroutine */ int send_real_32bit__();
    static real trmtgo;
    extern /* Subroutine */ int estrel_();
    static real tmguid;
    static shortint idpass;
    extern /* Subroutine */ int kvauto_();
    static real tcwait;
    extern /* Subroutine */ int vcslog_();
    static real tofltm, tburnp, tburny;
    extern /* Subroutine */ int acsthr2_();
    static real tgoflm;
    extern /* Subroutine */ int resthr_(), vcsthr2_();
    static real cms[9];
    extern /* Subroutine */ int cw87_();
    static real vgm[3], tgo, tatab_s__, sw80;
    static shortint ivtab_s__;
    static real ixx, iyy, izz;
    static shortint idrop_s__;
    static real tvtab_s__, tge1, tge2, ti2m[9];
    extern /* Subroutine */ int receive_signed_16bit__();

/*     THE FOLLOWING COMMON BLOCKS USED FOR MIDFLIGHT CAPABILITIES ONLY
*/

/*     OUTPUTS */
/*     NAMELIST INPUTS */
/* DATA INITIALIZATION */
```

```
/* $INCLUDE('^/INCLUDE/SSDATA35.DAT') */
/* $INCLUDE('^/INCLUDE/SSDATA38.DAT') */
/* $INCLUDE('^/INCLUDE/SSDATA39.DAT') */
/* $INCLUDE('^/INCLUDE/SSDATA42.DAT') */
/* $INCLUDE('^/INCLUDE/SSDATA44.DAT') */
/* $INCLUDE('^/INCLUDE/SSDATA45.DAT') */
/* $INCLUDE('^/INCLUDE/SSDATA46.DAT') */
/* $INCLUDE('^/INCLUDE/SSDATA47.DAT') */
/* $INCLUDE('^/INCLUDE/SSDATA48.DAT') */
/* $INCLUDE('^/INCLUDE/SSDATA49.DAT') */
/* $INCLUDE('^/INCLUDE/SSDATA50.DAT') */
/* $INCLUDE('^/INCLUDE/SSDATA01.DAT') */
/* $INCLUDE('^/INCLUDE/SSDATA17.DAT') */
/* $INCLUDE('^/INCLUDE/SSDATA18.DAT') */
/* $INCLUDE('^/INCLUDE/SSDATA21.DAT') */
/* $INCLUDE('^/INCLUDE/SSDATA22.DAT') */
/* $INCLUDE('^/INCLUDE/SSDATA23.DAT') */
/* $INCLUDE('^/INCLUDE/SSDATA28.DAT') */
/* $INCLUDE('^/INCLUDE/SSDATA29.DAT') */
/* $INCLUDE('^/INCLUDE/SSDATA30.DAT') */
/* $INCLUDE('^/INCLUDE/SSDATA71.DAT') */
/* $INCLUDE('^/INCLUDE/SSTIMING.DAT') */
/* $INCLUDE(':pfp:INCLUDE/target.for') */
/* INITIALIZE 80x87 */
    cw87_();
/* $INCLUDE('SSp11.DAT') */
    mcauto_(&t, &ixx, &iyy, &izz, &sp, &sq, &sr, &roller, &piter,
&yawer, &
            idist, &iacson, &iburnd, &iburnm, &idmeas, &ipassm, &icmd, &
            traton, &tpaton, &tyaton, &dtsamp, &tsal, &tsah, &tlaps,
&ithres,
            &anvp, &acslev, &tmauto, &cs__0);
    idrop_s__ = idrop;
    acslev_s__ = acslev;
    dtacsa_s__[0] = dtacsa[0];
    dtacsa_s__[1] = dtacsa[1];
    dtacsa_s__[2] = dtacsa[2];
    dtacsa_s__[3] = dtacsa[3];
    dtacsb_s__[0] = dtacsb[0];
    dtacsb_s__[1] = dtacsb[1];
    dtacsb_s__[2] = dtacsb[2];
    dtacsb_s__[3] = dtacsb[3];
    dtoffv_s__[0] = dtoffv[0];
    dtoffv_s__[1] = dtoffv[1];
    dtoffv_s__[2] = dtoffv[2];
    dtoffv_s__[3] = dtoffv[3];
    ithres_s__ = ithres;
    ivcs_s__ = ivcs;
    ivtab_s__ = ivtab;
    tatab_s__ = tatab;
    tburnm_s__ = tburnm;
    timonv_s__ = timonv;
    tofflt_s__[0] = tofflt[0];
    tofflt_s__[1] = tofflt[1];
    tofflt_s__[2] = tofflt[2];
    tofflt_s__[3] = tofflt[3];
    tvtab_s__ = tvtab;
/*
-----------------------------------------------------------------
-----C */
/* ------------------------------ MAIN EXECUTION LOOP
--------------------C */
/*
-----------------------------------------------------------------
```

```
-----C */
/*                                Execution of all events is performed
C
*/
/*                                within this loop
C
*/
/*
C
*/
/*
------------------------------------------------------------------
-----C */
L1000:
/*     WRITE(*,*)'--------------BEGINNING OF LOOP-----------------' */
/*
------------------------------------------------------------------
-----C */
/* ------------------------ Processor communication
----------------------C */
/*
------------------------------------------------------------------
-----C */
/* ------------------------ COMMUNICATION WITH P00
----------------------C */
    receive_real_32bit__(&ixx);
    receive_real_32bit__(&iyy);
    receive_real_32bit__(&izz);
    receive_real_32bit__(&mass);
/* ------------------------ COMMUNICATION WITH P00
------------------------C */
    send_signed_16bit__(&idrop_s__);
/* ------------------------ COMMUNICATION WITH P02
----------------------C */
    send_real_32bit__(&acslev_s__);
    send_real_32bit__(dtacsa_s__);
    send_real_32bit__(&dtacsa_s__[1]);
    send_real_32bit__(&dtacsa_s__[2]);
    send_real_32bit__(&dtacsa_s__[3]);
    send_real_32bit__(dtacsb_s__);
    send_real_32bit__(&dtacsb_s__[1]);
    send_real_32bit__(&dtacsb_s__[2]);
    send_real_32bit__(&dtacsb_s__[3]);
    send_real_32bit__(dtoffv_s__);
    send_real_32bit__(&dtoffv_s__[1]);
    send_real_32bit__(&dtoffv_s__[2]);
    send_real_32bit__(&dtoffv_s__[3]);
    send_signed_16bit__(&ithres_s__);
    send_signed_16bit__(&ivcs_s__);
    send_signed_16bit__(&ivtab_s__);
    send_real_32bit__(&tatab_s__);
    send_real_32bit__(&tburnm_s__);
    send_real_32bit__(&timonv_s__);
    send_real_32bit__(tofflt_s__);
    send_real_32bit__(&tofflt_s__[1]);
    send_real_32bit__(&tofflt_s__[2]);
    send_real_32bit__(&tofflt_s__[3]);
    send_real_32bit__(&tvtab_s__);
/* ------------------------ COMMUNICATION WITH P02
----------------------C */
    receive_signed_16bit__(&iacson);
/* ---------------- COMMUNICATE WITH CORVEL --------------C */
    receive_real_32bit__(vg);
    receive_real_32bit__(&vg[1]);
```

```
    receive_real_32bit__(&vg[2]);
/* ---------------- DAISY CHAIN WITH IMUPRO AND NAVIG
-------------------C */
    receive_real_32bit__(ti2m);
    receive_real_32bit__(&ti2m[1]);
    receive_real_32bit__(&ti2m[2]);
    receive_real_32bit__(&ti2m[3]);
    receive_real_32bit__(&ti2m[4]);
    receive_real_32bit__(&ti2m[5]);
    receive_real_32bit__(&ti2m[6]);
    receive_real_32bit__(&ti2m[7]);
    receive_real_32bit__(&ti2m[8]);
    receive_real_32bit__(vrel);
    receive_real_32bit__(&vrel[1]);
    receive_real_32bit__(&vrel[2]);
    receive_real_32bit__(rrel);
    receive_real_32bit__(&rrel[1]);
    receive_real_32bit__(&rrel[2]);
    receive_real_32bit__(&sp);
    receive_real_32bit__(&sq);
    receive_real_32bit__(&sr);
    send_real_32bit__(&magr);
    send_real_32bit__(&magv);
    send_real_32bit__(&tgo);
    send_real_32bit__(&piter);
    send_real_32bit__(&roller);
    send_real_32bit__(&yawer);
    send_signed_16bit__(&iburn1);
    send_real_32bit__(lamd);
    send_real_32bit__(&lamd[1]);
    send_signed_16bit__(&acqd);
    receive_signed_16bit__(&estate);
    receive_real_32bit__(&piter);
    receive_real_32bit__(&roller);
    receive_real_32bit__(&yawer);
    receive_signed_16bit__(&iburn1);
    receive_real_32bit__(lamd);
    receive_real_32bit__(&lamd[1]);
    receive_signed_16bit__(&acqd);
    receive_real_32bit__(&tgel);
    receive_real_32bit__(&tge2al);
    receive_real_32bit__(&trmtgo);
/*
-----------------------------------------------------------------
-----C */
/*                              ON BOARD GUIDANCE PROCESSING
C
*/
/*
-----------------------------------------------------------------
-----C */
/*                              Determine guidance commands
C
*/
/*
C
*/
/*
-----------------------------------------------------------------
-----C */
    if (tstep >= tgpudriv) {
/*          TGPUDRIV = TGPUDRIV + TGPUSTEP */
/*
-----------------------------------------------------------------
```

```
---------C */
/* ---------------------------- ESTIMATED RELATIVE STATES MODULE
--------C */
/*
-------------------------------------------------------------
---------C */
/*                              Estimate range, range rate, and
time-to- C */
/*                              go based on navigation output and
target C */
/*                              model estimates
  C */
/*
  C */
/*
-------------------------------------------------------------
---------C */
      estrel_(ti2m, cms, &estate, rrel, vrel, &magr, &magv, urrel,
&mgrdot,
            &tgo, &piter, &yawer, lamd);
    }
/*
-------------------------------------------------------------------
-----C */
/* ------------------------ Processor communication
----------------------C */
/*
-------------- ----------------------------------------------------
-----C */
/* ------------------------ COMMUNICATION WITH P00
-----------------------C */
    receive_real_32bit__(&ixx);
    receive_real_32bit__(&iyy);
    receive_real_32bit__(&izz);
    receive_real_32bit__(&mass);
/* ---------------------- COMMUNICATION WITH P00
---------------------- C */
    send_signed_16bit__(&idrop_s__);
/* ------------------------ COMMUNICATION WITH P02
-----------------------C */
    send_real_32bit__(&acslev_s__);
    send_real_32bit__(dtacsa_s__);
    send_real_32bit__(&dtacsa_s__[1]);
    send_real_32bit__(&dtacsa_s__[2]);
    send_real_32bit__(&dtacsa_s__[3]);
    send_real_32bit__(dtacsb_s__);
    send_real_32bit__(&dtacsb_s__[1]);
    send_real_32bit__(&dtacsb_s__[2]);
    send_real_32bit__(&dtacsb_s__[3]);
    send_real_32bit__(dtoffv_s__);
    send_real_32bit__(&dtoffv_s__[1]);
    send_real_32bit__(&dtoffv_s__[2]);
    send_real_32bit__(&dtoffv_s__[3]);
    send_signed_16bit__(&ithres_s__);
    send_signed_16bit__(&ivcs_s__);
    send_signed_16bit__(&ivtab_s__);
    send_real_32bit__(&tatab_s__);
    send_real_32bit__(&tburnm_s__);
    send_real_32bit__(&timonv_s__);
    send_real_32bit__(tofflt_s__);
    send_real_32bit__(&tofflt_s__[1]);
    send_real_32bit__(&tofflt_s__[2]);
    send_real_32bit__(&tofflt_s__[3]);
    send_real_32bit__(&tvtab_s__);
```

```
/* ---------------------- COMMUNICATION WITH P02
------------------ ---C */
    receive_signed_16bit__(&iacscn);
/* ---------------- COMMUNICATE WITH CORVEL --------------C */
    receive_real_32bit__(vg);
    receive_real_32bit__(&vg[1]);
    receive_real_32bit__(&vg[2]);
/* ---------------- DAISY CHAIN WITH IMUPRO AND NAVIG
-------------------C */
    receive_real_32bit__(ti2m);
    receive_real_32bit__(&ti2m[1]);
    receive_real_32bit__(&ti2m[2]);
    receive_real_32bit__(&ti2m[3]);
    receive_real_32bit__(&ti2m[4]);
    receive_real_32bit__(&ti2m[5]);
    receive_real_32bit__(&ti2m[6]);
    receive_real_32bit__(&ti2m[7]);
    receive_real_32bit__(&ti2m[8]);
    receive_real_32bit__(vrel);
    receive_real_32bit__(&vrel[1]);
    receive_real_32bit__(&vrel[2]);
    receive_real_32bit__(rrel);
    receive_real_32bit__(&rrel[1]);
    receive_real_32bit__(&rrel[2]);
    receive_real_32bit__(&sp);
    receive_real_32bit__(&sq);
    receive_real_32bit__(&sr);
/*
-------------------------------------------------------------------
-----C */
/* --------------------------- MISSILE STATE UPDATE MODULE
-------------C */
/*
-------------------------------------------------------------------
-----C */
/*                              Integrate missile states to current time
C
*/
/*
C
*/
/*
-------------------------------------------------------------------
-----C */
/*
-------------------------------------------------------------------
-----C */
/* ---------------------------- VCS THRUSTER RESPONSE MODULE
-----------C */
/*
-------------------------------------------------------------------
-----C */
/*                                Determines the forces and moments
C
*/
/*                                imparted by the VCS thrusters
C
*/
/*
C
*/
/*
-------------------------------------------------------------------
-----C */
```

```
    if (t >= tkvon) {
      vcsthr2_(&t, fltc, &fltcp, &fltcy, &tburnm, toffflt, &timonv,
&ivtab);
/*
-------------------------------------------------------------
---------C */
/* ------------------------- ACS THRUSTER RESPONSE MODULE
----------C */
/*
-------------------------------------------------------------
---------C */
/*                                Determines the forces and moments
  C */
/*                                imparted by the ACS thrusters
  C */
/*
  C */
/*
-------------------------------------------------------------
---------C */
      acsthr2_(&ithres);
    }
/*
-------------------------------------------------------------
-----C */
/* ------------------------ -------- SEPARATION MODULE
----------------------C */
/*
-------------------------------------------------------------
-----C */
/*                                Models discontinuities occuring during
C
*/
/*                                stage separation
C
*/
/*
C
*/
/*
-------------------------------------------------------------
-----C */
/*        NOSE FAIRING / BOOST ADAPTER SEPARATION */
    if (idrop == 1 || (r_1 = t - tdrop, dabs(r_1)) <= dteps && igit ==
1) {
      idrop = 2;
      ipassm = 0;
    }
    if (tstep >= tgpudriv) {
      tgpudriv += tgpustep;
/*
-------------------------------------------------------------
---------C */
/* ------------------------- MIDCOURSE GUIDANCE MODULE
------------------C */
/*
-------------------------------------------------------------
---------C */
/*                                Calculates roll error, controls
  C */
/*                                midcourse sequencing, and issues
  C */
/*                                midcourse diverts
  c */
```

```
/*
-------------------------------------------------------------
---------C */
      if (t > tstg2 && t >= tmguid && acqd == 0) {
          mcguid_(&t, ti2m, vg, urrel, &mass, &idist, &midbrn, &magr,
&magv,
                  &sp, &sq, &sr, &piter, &yawer, &flip, &ivcs, &icmd, &
                 idmeas, &idpass, &idrop, &imcend, &iburnd, &iburnm, vgm,
                 adistt, &roller, &tmguid);
      }
    }
/*
-------------------------------------------------------------------
-----C */
/* --------------------------- KALMAN FILTER MODULE
--------------------C */
/*
-------------------------------------------------------------------
-----C */
    send_real_32bit__(&magr);
    send_real_32bit__(&magv);
    send_real_32bit__(&tgo);
    send_real_32bit__(&piter);
    send_real_32bit__(&roller);
    send_real_32bit__(&yawer);
    send_signed_16bit__(&iburni),
    send_real_32bit__(lamd);
    send_real_32bit__(&lamd[1]);
    send_signed_16bit__(&acqd);
    receive_signed_16bit__(&estate);
    receive_real_32bit__(&piter);
    receive_real_32bit__(&roller);
    receive_real_32bit__(&yawer);
    receive_signed_16bit__(&iburn1);
    receive_real_32bit__(lamd);
    receive_real_32bit__(&lamd[1]);
    receive_signed_16bit__(&acqd);
    receive_real_32bit__(&tge1);
    receive_real_32bit__(&tge2a1);
    receive_real_32bit__(&trmtgo);
/*
-------------------------------------------------------------------
-----C */
/* ---------------------- Processor communication
---------------------C */
/*
-------------------------------------------------------------------
-----C */
/* ----------------------- COMMUNICATION WITH P00
----------------------C */
    receive_real_32bit__(&ixx);
    receive_real_32bit__(&iyy);
    receive_real_32bit__(&izz);
    receive_real_32bit__(&mass);
/* ----------------------- COMMUNICATION WITH P00
----------------------C */
    send_signed_16bit__(&idrop_s__);
/* ---------------------- COMMUNICATION WITH P02
----------------------C */
    send_real_32bit__(&acslev_s__);
    send_real_32bit__(dtacsa_s__);
    send_real_32bit__(&dtacsa_s__[1]);
    send_real_32bit__(&dtacsa_s__[2]);
    send_real_32bit__(&dtacsa_s__[3]);
```

```
    send_real_32bit__(dtacsb_s__);
    send_real_32bit__(&dtacsb_s__[1]);
    send_real_32bit__(&dtacsb_s__[2]);
    send_real_32bit__(&dtacsb_s__[3]);
    send_real_32bit__(dtoffv_s__);
    send_real_32bit__(&dtoffv_s__[1]);
    send_real_32bit__(&dtoffv_s__[2]);
    send_real_32bit__(&dtoffv_s__[3]);
    send_signed_16bit__(&ithres_s__);
    send_signed_16bit__(&ivcs_s__);
    send_signed_16bit__(&ivtab_s__);
    send_real_32bit__(&tatab_s__);
    send_real_32bit__(&tburnm_s__);
    send_real_32bit__(&timonv_s__);
    send_real_32bit__(tofflt_s__);
    send_real_32bit__(&tofflt_s__[1]);
    send_real_32bit__(&tofflt_s__[2]);
    send_real_32bit__(&tofflt_s__[3]);
    send_real_32bit__(&tvtab_s__);
/* ----------------------- COMMUNICATION WITH P02
-----------------------C */
    receive_signed_16bit__(&iacson);
/* ---------------- COMMUNICATE WITH CORVEL --------------C */
    receive_real_32bit__(vg);
    receive_real_32bit__(&vg[1]);
    receive_real_32bit__(&vg[2]);
/* ---------------- DAISY CHAIN WITH IMUPRO AND NAVIG
-------------------C */
    receive_real_32bit__(ti2m);
    receive_real_32bit__(&ti2m[1]);
    receive_real_32bit__(&ti2m[2]);
    receive_real_32bit__(&ti2m[3]);
    receive_real_32bit__(&ti2m[4]);
    receive_real_32bit__(&ti2m[5]);
    receive_real_32bit__(&ti2m[6]);
    receive_real_32bit__(&ti2m[7]);
    receive_real_32bit__(&ti2m[8]);
    receive_real_32bit__(vrel);
    receive_real_32bit__(&vrel[1]);
    receive_real_32bit__(&vrel[2]);
    receive_real_32bit__(rrel);
    receive_real_32bit__(&rrel[1]);
    receive_real_32bit__(&rrel[2]);
    receive_real_32bit__(&sp);
    receive_real_32bit__(&sq);
    receive_real_32bit__(&sr);
    send_real_32bit__(&magr);
    send_real_32bit__(&magv);
    send_real_32bit__(&tgo);
    send_real_32bit__(&piter);
    send_real_32bit__(&roller);
    send_real_32bit__(&yawer);
    send_signed_16bit__(&iburn1);
    send_real_32bit__(lamd);
    send_real_32bit__(&lamd[1]);
    send_signed_16bit__(&acqd);
    receive_signed_16bit__(&estate);
    receive_real_32bit__(&piter);
    receive_real_32bit__(&roller);
    receive_real_32bit__(&yawer);
    receive_signed_16bit__(&iburn1);
    receive_real_32bit__(lamd);
    receive_real_32bit__(&lamd[1]);
    receive_signed_16bit__(&acqd);
```

```
    receive_real_32bit__(&tge1);
    receive_real_32bit__(&tge2a1);
    receive_real_32bit__(&trmtgo);
/*
-----------------------------------------------------------------
-----C */
/* ------------------------------ AUTOPILOTS
--------------------------C */
/*
-----------------------------------------------------------------
-----C */
/*
C
*/
/*
-----------------------------------------------------------------
-----C */
    if (tstep >= tapudriv) {
/*
-------------------------------------------------------------
---------C */
/* ---------------------- MIDCOURSE AUTOPILOT MODULE
----------------------C */
/*
-------------------------------------------------------------
---------C */
/*                              Performs large angle reorients and
rate  C */
/*                              control during midcourse
  C */
/*
-------------------------------------------------------------
---------C */
      if (t >= tkvon) {
          if (t > tstg2 && t >= tmauto && (icmd != 0 || acqd == 0)) {
            mcauto_(&t, &ixx, &iyy, &izz, &sp, &sq, &sr, &roller,
&piter,
                  &yawer, &idist, &iacson, &iburnd, &iburnm, &idmeas, &
                  ipassm, &icmd, &traton, &tpaton, &tyaton, &dtsamp, &
                  tsal, &tsah, &tlaps, &ithres, &anvp, &acslev, &tmauto,
                   &cs__1);
          }
      }
    }
/*
-----------------------------------------------------------------
-----C */
/* ------------------------ Processor communication
----------------------C */
/*
-----------------------------------------------------------------
-----C */
    idrop_s__ = idrop;
/* ----------------------- COMMUNICATION WITH P00
-----------------------C */
    receive_real_32bit__(&ixx);
    receive_real_32bit__(&iyy);
    receive_real_32bit__(&izz);
    receive_real_32bit__(&mass);
/* ----------------------- COMMUNICATION WITH P00
-----------------------C */
    send_signed_16bit__(&idrop_s__);
/* ----------------------- COMMUNICATION WITH P02
-----------------------C */
```

```
    send_real_32bit__(&acslev_s__);
    send_real_32bit__(dtacsa_s__);
    send_real_32bit__(&dtacsa_s__[1]);
    send_real_32bit__(&dtacsa_s__[2]);
    send_real_32bit__(&dtacsa_s__[3]);
    send_real_32bit__(dtacsb_s__);
    send_real_32bit__(&dtacsb_s__[1]);
    send_real_32bit__(&dtacsb_s__[2]);
    send_real_32bit__(&dtacsb_s__[3]);
    send_real_32bit__(dtoffv_s__);
    send_real_32bit__(&dtoffv_s__[1]);
    send_real_32bit__(&dtoffv_s__[2]);
    send_real_32bit__(&dtoffv_s__[3]);
    send_signed_16bit__(&ithres_s__);
    send_signed_16bit__(&ivcs_s__);
    send_signed_16bit__(&ivtab_s__);
    send_real_32bit__(&tatab_s__);
    send_real_32bit__(&tburnm_s__);
    send_real_32bit__(&timonv_s__);
    send_real_32bit__(tofflt_s__);
    send_real_32bit__(&tofflt_s__[1]);
    send_real_32bit__(&tofflt_s__[2]);
    send_real_32bit__(&tofflt_s__[3]);
    send_real_32bit__(&tvtab_s__);
/* ----------------------- COMMUNICATION WITH P02
-----------------------C */
    receive_signed_16bit__(&iacson);
/* ---------------- COMMUNICATE WITH CORVEL -------------C */
    receive_real_32bit__(vg);
    receive_real_32bit__(&vg[1]);
    receive_real_32bit__(&vg[2]);
/* ----------------- DAISY CHAIN WITH IMUPRO AND NAVIG
-------------------C */
    receive_real_32bit__(ti2m);
    receive_real_32bit__(&ti2m[1]);
    receive_real_32bit__(&ti2m[2]);
    receive_real_32bit__(&ti2m[3]);
    receive_real_32bit__(&ti2m[4]);
    receive_real_32bit__(&ti2m[5]);
    receive_real_32bit__(&ti2m[6]);
    receive_real_32bit__(&ti2m[7]);
    receive_real_32bit__(&ti2m[8]);
    receive_real_32bit__(vrel);
    receive_real_32bit__(&vrel[1]);
    receive_real_32bit__(&vrel[2]);
    receive_real_32bit__(rrel);
    receive_real_32bit__(&rrel[1]);
    receive_real_32bit__(&rrel[2]);
    receive_real_32bit__(&sp);
    receive_real_32bit__(&sq);
    receive_real_32bit__(&sr);
    send_real_32bit__(&magr);
    send_real_32bit__(&magv);
    send_real_32bit__(&tgo);
    send_real_32bit__(&piter);
    send_real_32bit__(&roller);
    send_real_32bit__(&yawer);
    send_signed_16bit__(&iburn1);
    send_real_32bit__(lamd);
    send_real_32bit__(&lamd[1]);
    send_signed_16bit__(&acqd);
    receive_signed_16bit__(&estate);
    receive_real_32bit__(&piter);
    receive_real_32bit__(&roller);
```

```
    receive_real_32bit__(&yawer);
    receive_signed_16bit__(&iburn1);
    receive_real_32bit__(lamd);
    receive_real_32bit__(&lamd[1]);
    receive_signed_16bit__(&acqd);
    receive_real_32bit__(&tge1);
    receive_real_32bit__(&tge2a1);
    receive_real_32bit__(&trmtgo);
/*
-----------------------------------------------------------------
-----C */
/* ------------------------------ AUTOPILOTS
--------------------------C */
/*
-----------------------------------------------------------------
-----C */
/*
C
*/
/*
-----------------------------------------------------------------
-----C */
    if (tstep >= tapudriv) {
      if (t >= tkvon) {
/*
-------------------------------------------------------
-------------C */
/* ---------------------------- KV AUTOPILOT MODULE
--------------------C */
/*
-------------------------------------------------------
-------------C */
/*                                Calls the various ACS autopilot
      C */
/*                                modes used for controlling the
      C */
/*                                kill vehicle attitude during
flight.     C */
/*                                Its purpose is to define which
      C */
/*                                thruster to burn, for how long,
and at   C */
/*                                what thrust level.
      C */
/*
      C */
/*
-------------------------------------------------------
-------------C */
          kvauto_(&t, &sp, &sq, &sr, &fltcp, &fltcy, &ixx, &iyy, &izz,
                adistt, &roller, &piter, &yawer, &tcwait, &idist, &sw80,
&
                tsal, &tsah, &tnext, &tlaps, &anvp, &dtsamp, &acslev, &
                traton, &tpaton, &tyaton, &ithres);
      }
    }
/* ----------------------- COMMUNICATION WITH P00
-----------------------C */
    receive_real_32bit__(&ixx);
    receive_real_32bit__(&iyy);
    receive_real_32bit__(&izz);
    receive_real_32bit__(&mass);
/* ----------------------- COMMUNICATION WITH P00
-----------------------C */
```

```
    send_signed_16bit__(&idrop_s__);
/* ----------------------- COMMUNICATION WITH P02
-----------------------C */
    send_real_32bit__(&acslev_s__);
    send_real_32bit__(dtacsa_s__);
    send_real_32bit__(&dtacsa_s__[1]);
    send_real_32bit__(&dtacsa_s__[2]);
    send_real_32bit__(&dtacsa_s__[3]);
    send_real_32bit__(dtacsb_s__);
    send_real_32bit__(&dtacsb_s__[1]);
    send_real_32bit__(&dtacsb_s__[2]);
    send_real_32bit__(&dtacsb_s__[3]);
    send_real_32bit__(dtoffv_s__);
    send_real_32bit__(&dtoffv_s__[1]);
    send_real_32bit__(&dtoffv_s__[2]);
    send_real_32bit__(&dtoffv_s__[3]);
    send_signed_16bit__(&ithres_s__);
    send_signed_16bit__(&ivcs_s__);
    send_signed_16bit__(&ivtab_s__);
    send_real_32bit__(&tatab_s__);
    send_real_32bit__(&tburnm_s__);
    send_real_32bit__(&timonv_s__);
    send_real_32bit__(tofflt_s__);
    send_real_32bit__(&tofflt_s__[1]);
    send_real_32bit__(&tofflt_s__[2]);
    send_real_32bit__(&tofflt_s__[3]);
    send_real_32bit__(&tvtab_s__);
/* ----------------------- COMMUNICATION WITH P02
-----------------------C */
    receive_signed_16bit__(&iacson);
/* ---------------- COMMUNICATE WITH CORVEL --------------C */
    receive_real_32bit__(vg);
    receive_real_32bit__(&vg[1]);
    receive_real_32bit__(&vg[2]);
/* ---------------- DAISY CHAIN WITH IMUPRO AND NAVIG
-------------------C */
    receive_real_32bit__(ti2m);
    receive_real_32bit__(&ti2m[1]);
    receive_real_32bit__(&ti2m[2]);
    receive_real_32bit__(&ti2m[3]);
    receive_real_32bit__(&ti2m[4]);
    receive_real_32bit__(&ti2m[5]);
    receive_real_32bit__(&ti2m[6]);
    receive_real_32bit__(&ti2m[7]);
    receive_real_32bit__(&ti2m[8]);
    receive_real_32bit__(vrel);
    receive_real_32bit__(&vrel[1]);
    receive_real_32bit__(&vrel[2]);
    receive_real_32bit__(rrel);
    receive_real_32bit__(&rrel[1]);
    receive_real_32bit__(&rrel[2]);
    receive_real_32bit__(&sp);
    receive_real_32bit__(&sq);
    receive_real_32bit__(&sr);
    send_real_32bit__(&magr);
    send_real_32bit__(&magv);
    send_real_32bit__(&tgo);
    send_real_32bit__(&piter);
    send_real_32bit__(&roller);
    send_real_32bit__(&yawer);
    send_signed_16bit__(&iburn1);
    send_real_32bit__(lamd);
    send_real_32bit__(&lamd[1]);
    send_signed_16bit__(&acqd);
```

```
    receive_signed_16bit__(&estate);
    receive_real_32bit__(&piter);
    receive_real_32bit__(&roller);
    receive_real_32bit__(&yawer);
    receive_signed_16bit__(&iburn1);
    receive_real_32bit__(lamd);
    receive_real_32bit__(&lamd[1]);
    receive_signed_16bit__(&acqd);
    receive_real_32bit__(&tge1);
    receive_real_32bit__(&tge2al);
    receive_real_32bit__(&trmtgo);
/*
-----------------------------------------------------------------
-----C */
/* ------------------------------ AUTOPILOTS
--------------------------C */
/*
-----------------------------------------------------------------
-----C */
/*
C
*/
/*
-----------------------------------------------------------------
-----C */
    if (tstep >= tapudriv) {
      tapudriv += tapustep;
      if (t >= tkvon) {
/*
-------------------------------------------------------
-------------C */
/* ---------------------------- VCS LOGIC MODULE
------------------------C */
/*
-------------------------------------------------------
-------------C */
/*                              Controls the kill vehicle velocity
by    C */
/*                              determining the appropriate VCS
thruster C */
/*                              on and off times.
      C */
/*
      C */
/*
-------------------------------------------------------
-------------C */
          vcslog_(&t, &mass, lamd, &tgo, &magv, &tgi1, &trmtgo, &tge2al,
&
                tge1, vgm, &ivcs, &idmeas, &iburnm, &midbrn, &iburn1, &
                iburn2, &iburn3, &idist, fltc, &fltcp, &fltcy, &tsal, &
                tsah, tofflt, &tofltm, &tburnp, &tburny, &tge2, &tgi1p,
&
                tgi2p, &tgi3p, &tgi1y, &tgi2y, &tgi3y, &timonv, &tgoflm,
&
                tcwait, dtvcsp, dtvcsy, dtoffv, &tburnm);
/*          SET FLAG TO COMPUTE VCS THRUSTER RESPONSE TABLE */
          ivtab = 1;
          tvtab = t;
/*
-------------------------------------------------------
-------------C */
/* ---------------------------- ACS RESOLVING LOGIC MODULE
-------------C */
```

```
/*
-------------------------------------------------------
------------C */
/*
      C */
          if (ithres == 1) {
            resthr_(&t, &idist, &anvp, &dtsamp, &tofltm, &traton,
&tpaton,
                    &tyaton, dtacsa, dtacsb);
/*              BEGINNING TIME OF ACS THRUSTER RESPONSE TABLE
*/
            tatab = t;
          }
      }
    }
    ithres_s__ = ithres;
    acslev_s__ = acslev;
    dtacsa_s__[0] = dtacsa[0];
    dtacsa_s__[1] = dtacsa[1];
    dtacsa_s__[2] = dtacsa[2];
    dtacsa_s__[3] = dtacsa[3];
    dtacsb_s__[0] = dtacsb[0];
    dtacsb_s__[1] = dtacsb[1];
    dtacsb_s__[2] = dtacsb[2];
    dtacsb_s__[3] = dtacsb[3];
    dtoffv_s__[0] = dtoffv[0];
    dtoffv_s__[1] = dtoffv[1];
    dtoffv_s__[2] = dtoffv[2];
    dtoffv_s__[3] = dtoffv[3];
    ivcs_s__ = ivcs;
    ivtab_s__ = ivtab;
    tatab_s__ = tatab;
    tburnm_s__ = tburnm;
    timonv_s__ = timonv;
    tofflt_s__[0] = tofflt[0];
    tofflt_s__[1] = tofflt[1];
    tofflt_s__[2] = tofflt[2];
    tofflt_s__[3] = tofflt[3];
    tvtab_s__ = tvtab;
/*
----------  ----------------------------------------------
-----C */
/* ----------------------------- TERMINATION LOGIC
----------------------C */
/*
-----------------------------------------------------------------
-----C */
/*                                Defines the simulation termination
C
*/
/*                                conditions
C
*/
/*
C
*/
/*
-----------------------------------------------------------------
-----C */
/*     INITIALIZE SIMULATION EXIT FLAG TO ZERO ( PREVENTS EXIT ) */
    iexit = 0;
/*     ENABLE EXIT IF MAXIMUM SIMULATION TIME HAS BEEN EXECUTED AND ALL
*/
```

```
/*      EVENTS SCHEDULED FOR THIS TIME HAVE BEEN EXECUTED */
     if (t >= tfinal) {
       iexit = 1;
     }
/*      increment time */
     tstep += (float)5.;
     t = tstep * delt;
/*      CONTINUE LOOPING UNTIL ONE OR MORE EXIT CONDITIONS HAVE BEEN MET
*/

     if (iexit == 0) {
       goto L1000;
     }
} /* MAIN__ */
```

## B.3.13 Uup12.c

```
/* uup12.f -- translated by f2c (version of 3 February 1990  3:36:42).
   You must link the resulting object file with the libraries:
      -lF77 -lI77 -lm -lc   (in that order)
*/

#include "f2c.h"

/* Common Block Declarations */

struct {
    real tkf;
    shortint idrtok;
    real pp11, pp12, pp22, py11, py12, py22, plmdfp, ylmdfp, plamh,
ylamh,
          plamdh, ylamdh, plamdf, ylamdf, tgil;
    shortint kfmode, ifpas;
} rkalmn_;

#define rkalmn_1 rkalmn_

/* Table of constant values */

static doublereal c_b2 = -.29912;

/*      PROGRAM EXOSIM */
/* ------------------------------------------------------------------
-C */
/* ---------------- Declare and initialize variables  ----------------
-C */
/* ------------------------------------------------------------------
-C */
/* Main program */ MAIN__()
{
    /* System generated locals */
    doublereal d_1;

    /* Builtin functions */
    double pow_dd();

    /* Local variables */
    static shortint acqd;
    static real lamd[2];
    static shortint macq;
    static real asig, magr, lamm[2], delt, magv, racq, dtacsa_s__[4],
          dtacsb_s__[4], rrel[3], vrel[3];
    static shortint term, ivcs, mcso;
    static real acslev_s__, dtoffv_s__[4], tofflt_s__[4];
    static shortint ithres_s__;
    extern /* Subroutine */ int send_signed_16bit__();
    static real tburnm_s__, tkfudriv, timonv_s__, t, tatab;
    static shortint track, ivcab, idrop;
    static real tvtab;
    static shortint iexit;
    static real piter;
    static shortint mterm;
    static real wfilt, yawer, zfilt, tstep;
    extern /* Subroutine */ int receive_real_32bit__();
    static real tge2al;
    static shortint iburn1;
    static real dtacsa[4], dtacsb[4];
    extern /* Subroutine */ int kalman_();
```

```
    static real lamsek[2], acslev, tfinal;
    static shortint estate, ivcs_s__;
    static real snracq, dtoffv[4], magrtr, lamdxx[2], tofflt[4];
    static shortint ithres;
    static real frmrat, tburnm;
    static shortint ireslv;
    static real roller;
    extern /* Subroutine */ int send_real_32bit__();
    static real timonv, trmtgo;
    static shortint sektyp;
    static real lam[2], cms[9];
    extern /* Subroutine */ int cw87_();
    static real tatab_s__, tgo, snr;
    static shortint ivtab_s__, idrop_s__;
    static real tvtab_s__, tgel, ti2m[9];
    extern /* Subroutine */ int receive_signed_16bit__();

/*     THE FOLLOWING COMMON BLOCKS USED FOR MIDFLIGHT CAPABILITIES ONLY
*/

/*     OUTPUTS */
/*     NAMELIST INPUTS */
/* DATA INITIALIZATION */
/* $INCLUDE('^/INCLUDE/SSDATA35.DAT') */
/* $INCLUDE('^/INCLUDE/SSDATA38.DAT') */
/* $INCLUDE('^/INCLUDE/SSDATA39.DAT') */
/* $INCLUDE('^/INCLUDE/SSDATA42.DAT') */
/* $INCLUDE('^/INCLUDE/SSDATA44.DAT') */
/* $INCLUDE('^/INCLUDE/SSDATA45.DAT') */
/* $INCLUDE('^/INCLUDE/SSDATA46.DAT') */
/* $INCLUDE('^/INCLUDE/SSDATA47.DAT') */
/* $INCLUDE('^/INCLUDE/SSDATA48.DAT') */
/* $INCLUDE('^/INCLUDE/SSDATA49.DAT') */
/* $INCLUDE('^/INCLUDE/SSDATA50.DAT') */
/* $INCLUDE('^/INCLUDE/SSDATA01.DAT') */
/* $INCLUDE('^/INCLUDE/SSDATA17.DAT') */
/* $INCLUDE('^/INCLUDE/SSDATA18.DAT') */
/* $INCLUDE('^/INCLUDE/SSDATA21.DAT') */
/* $INCLUDE('^/INCLUDE/SSDATA22.DAT') */
/* $INCLUDE('^/INCLUDE/SSDATA23.DAT') */
/* $INCLUDE('^/INCLUDE/SSDATA28.DAT') */
/* $INCLUDE('^/INCLUDE/SSDATA29.DAT') */
/* $INCLUDE('^/INCLUDE/SSDATA30.DAT') */
/* $INCLUDE('^/INCLUDE/SSDATA71.DAT') */
/* $INCLUDE('^/INCLUDE/SSTIMING.DAT') */
/* $INCLUDE(':pfp:INCLUDE/target.for') */
/* INITIALIZE 80x87 */
    cw87_();
/* $INCLUDE('SSp12.DAT') */
    idrop_s__ = idrop;
    acslev_s__ = acslev;
    dtacsa_s__[0] = dtacsa[0];
    dtacsa_s__[1] = dtacsa[1];
    dtacsa_s__[2] = dtacsa[2];
    dtacsa_s__[3] = dtacsa[3];
    dtacsb_s__[0] = dtacsb[0];
    dtacsb_s__[1] = dtacsb[1];
    dtacsb_s__[2] = dtacsb[2];
    dtacsb_s__[3] = dtacsb[3];
    dtoffv_s__[0] = dtoffv[0];
    dtoffv_s__[1] = dtoffv[1];
    dtoffv_s__[2] = dtoffv[2];
    dtoffv_s__[3] = dtoffv[3];
    ithres_s__ = ithres;
```

```
    ivcs_s__ = ivcs;
    ivtab_s__ = ivtab;
    tatab_s__ = tatab;
    tburnm_s__ = tburnm;
    timonv_s__ = timonv;
    tofflt_s__[0] = tofflt[0];
    tofflt_s__[1] = tofflt[1];
    tofflt_s__[2] = tofflt[2];
    tofflt_s__[3] = tofflt[3];
    tvtab_s__ = tvtab;
/*
-----------------------------------------------------------------------
-----C */
/* ------------------------------ MAIN EXECUTION LOOP
---------------------C */
/*
-----------------------------------------------------------------------
-----C */
/*                                Execution of all events is performed
C
*/
/*                                within this loop
C
*/
/*
C
*/
/*
-----------------------------------------------------------------------
-----C */
L1000:
/*      WRITE(*,*)'--------------BEGINNING OF LOOP-----------------' */
/*
-----------------------------------------------------------------------
-----C */
/* ------------------------ Processor communication
---------------------C */
/*
-----------------------------------------------------------------------
-----C */
/* ------------------------ COMMUNICATION WITH SEEKER
---------------------C */
    receive_real_32bit__(lamm);
    receive_real_32bit__(&lamm[1]);
    receive_real_32bit__(&snr);
    receive_real_32bit__(&frmrat);
/* ------------------------ COMMUNICATION WITH P03
----------------------C */
    receive_signed_16bit__(&ireslv);
    receive_real_32bit__(lamdxx);
    receive_real_32bit__(&lamdxx[1]);
    receive_real_32bit__(lamsek);
    receive_real_32bit__(&lamsek[1]);
    receive_real_32bit__(&magrtr);
/* ----------------- DAISY CHAIN WITH IMUPRO AND NAVIG
-------------------C */
    receive_real_32bit__(ti2m);
    receive_real_32bit__(&ti2m[1]);
    receive_real_32bit__(&ti2m[2]);
    receive_real_32bit__(&ti2m[3]);
    receive_real_32bit__(&ti2m[4]);
    receive_real_32bit__(&ti2m[5]);
    receive_real_32bit__(&ti2m[6]);
    receive_real_32bit__(&ti2m[7]);
```

```
    receive_real_32bit__(&ti2m[8]);
    receive_real_32bit__(vrel);
    receive_real_32bit__(&vrel[1]);
    receive_real_32bit__(&vrel[2]);
    receive_real_32bit__(rrel);
    receive_real_32bit__(&rrel[1]);
    receive_real_32bit__(&rrel[2]);
/*
-------------------------- ------------------------------------
-----C */
/* ---------------------------- KALMAN FILTER MODULE
--------------------C */
/*
-------------------------------------------- --------------------
-----C */
/*                              Filter LOS angles
C
*/
/*
C
*/
/*
-------------------------------------------------------------------
-----C */
    receive_real_32bit__(&magr);
    receive_real_32bit__(&magv);
    receive_real_32bit__(&tgo);
    receive_real_32bit__(&piter);
    receive_real_32bit__(&roller);
    receive_real_32bit__(&yawer);
    receive_signed_16bit__(&iburn1);
    receive_real_32bit__(lamd);
    receive_real_32bit__(&lamd[1]);
    receive_signed_16bit__(&acqd);
    if (tstep >= tkfudriv) {
/*         TKFUDRIV = TKFUDRIV + TKFUSTEP */
      tkfudriv += (shortint) ((float)1e3 / frmrat);
/*          write(message,103)t */
/* 103       format(' kalman',f10.4) */
/*          call outmes(message) */
/*        CALL FILTER IF SNR IS SUFFICIENT */
      if (snr >= snracq || sektyp != 2) {
          if (sektyp == 1 || sektyp == 2) {
            d_1 = (doublereal) snr;
            asig = pow_dd(&d_1, &c_b2) * (float)32.56 * (float)1e-6;
          }
          kalman_(&t, ti2m, lamm, &asig, &snr, &tgo, rrel, vrel, ti2m, &
                racq, &magrtr, &magr, &magv, lamsek, lamdxx, &frmrat,
cms,
                 &macq, &mcso, &mterm, &ireslv, &track, &term, &trmtgo,
&
                tgel, &tge2al, &wfilt, &zfilt, lam, lamd, &iburn1,
&acqa,
                &estate, &piter, &yawer, &roller);
      }
    }
    send_signed_16bit__(&estate);
    send_real_32bit  (&piter);
    send_real_32bit__(&roller);
    send_real_32bit__(&yawer);
    send_signed_16bit__(&iburn1);
    send_real_32bit__(lamd);
    send_real_32bit__(&lamd[1]);
    send_signed_16bit__(&acqd);
```

```
    send_real_32bit__(&tge1);
    send_real_32bit__(&tge2a1);
    send_real_32bit__(&trmtgo);
/*
-----------------------------------------------------------------
-----C */
/* ----------------------------- TERMINATION LOGIC
----------------------C */
/*
-----------------------------------------------------------------
-----C */
/*                                Defines the simulation termination
C
*/
/*                                conditions
C
*/
/*
C
*/
/*
-----------------------------------------------------------------
-----C */
/*     INITIALIZE SIMULATION EXIT FLAG TO ZERO ( PREVENTS EXIT ) */
    iexit = 0;
/*     ENABLE EXIT IF MAXIMUM SIMULATION TIME HAS BEEN EXECUTED AND ALL
*/

/*     EVENTS SCHEDULED FOR THIS TIME HA''E BEEN EXECUTED */
    if (t >= tfinal) {
      iexit = 1;
    }
/*     increment time */
    tstep += (float)1.;
    t = tstep * delt;
/*     CONTINUE LOOPING UNTIL ONE OR MORE EXIT CONDITIONS HAVE BEEN MET
*/

    if (iexit == 0) {
      goto L1000;
    }
} /* MAIN__ */
```

## A.4 Crossbar Code

```
#define relay y3
ssp00   is      ssp00.fpp       on x1
ssp01   is      ssp01.fpx       on x15
ssp02   is      ssp02.fpp       on x2
ssp03   is      ssp03.fpx       on x14
ssp04   is      ssp04.fpx       on x13
ssp05   is      ssp05.fpp       on x5
ssp06   is      ssp06.fpp       on x6
ssp07   is      ssp07.fpp       on x7
ssp08   is      ssp08.fpx       on y13
ssp09   is      ssp09.fpx     on y14
ssp10   is      ssp10.fpx       on x11
ssp11   is      ssp11.386       on x10
ssp12   is      ssp12.fpp       on x12

timer is    fpptimer.fpp      on y15
print   is      print.386       on p23

loop

cycle
  ssp01,ssp10 := ssp08.2;   [REAL GR(01) ]
[  relay,ssp01,ssp10 := ssp08.2;  REAL GR(01) ]

cycle
  ssp01,ssp10 := ssp08.2; [ REAL GR(02) ]
  print := ssp00.2; [REAL PHI]

cycle
  ssp01,ssp10 := ssp08.2; [ REAL GR(03) ]
  print := ssp00.2; [REAL THT]

cycle
  ssp11 := ssp00.2; [ REAL*8 IXX ]
  print := ssp01.2; [ T ]

cycle
  ssp11 := ssp00.2; [ REAL*8 IYY ]
  print := ssp08.2; [REAL ALT]

cycle
  ssp11 := ssp00.2; [ REAL*8 IZZ ]

cycle
  ssp01,ssp11,ssp06,ssp08 := ssp00.2; [ REAL*8 MASS ]

cycle
  ssp01 := ssp10.2; [ REAL*8 PULSEA(01) ]
  print := ssp00.2; [REAL PSI]

cycle
  ssp01 := ssp10.2; [ REAL*8 PULSEA(02) ]

cycle
  ssp01 := ssp10.2; [ REAL*8 PULSEA(03) ]

cycle
  ssp02,ssp10,ssp05 := ssp06.2; [ cg(1) ]
  ssp12 := ssp09.2; [ lamm(1) ]

cycle
```

```
  ssp01 := ssp04.2; [ REAL*8 PULSEG(01) ]
  ssp02,ssp10,ssp05 := ssp06.2; [ cg(2) ]
  ssp12 := ssp09.2; [ lamm(2) ]

cycle
  ssp01 := ssp04.2; [ REAL*8 PULSEG(02) ]
  ssp02,ssp10,ssp05 := ssp06.2; [ cg(3) ]
  ssp12 := ssp09.2; [ snr ]

cycle
  ssp01 := ssp04.2; [ REAL*8 PULSEG(03) ]
  ssp12 := ssp09.2; [ frmrat ]

cycle
  ssp01 := ssp08.4; [ REAL*8 XYZE(01) ]
  ssp04,ssp10 := ssp00.2; [ REAL*8 P ]

cycle
  ssp01 := ssp08.4; [ REAL*8 XYZE(02) ]
  ssp03,ssp04,ssp10 := ssp00.2; [ REAL*8 Q ]

cycle
  ssp01 := ssp08.4; [ REAL*8 XYZE(03) ]
  ssp03,ssp04,ssp10 := ssp00.2; [ REAL*8 R ]

cycle
  ssp01 := ssp08.4; [ REAL*8 XYZED(01) ]

cycle
  ssp01 := ssp08.4; [ REAL*8 XYZED(02) ]

cycle
  ssp01 := ssp08.4; [ REAL*8 XYZED(03) ]

cycle
  ssp01,ssp03 := ssp08.4; [ REAL*8 X ]

cycle
  ssp01,ssp03 := ssp08.4; [ REAL*8 Y ]

cycle
  ssp01,ssp03 := ssp08.4; [ REAL*8 Z ]

cycle
  ssp07,print := ssp08.2; [ REAL X ]

cycle
  ssp07,print := ssp08.2; [ REAL Y ]

cycle
  ssp07,print := ssp08.2; [ PEAL Z ]

cycle
  ssp00,ssp01,ssp03,ssp10,ssp07,print := ssp08.2; [ REAL XD ]

cycle
  ssp00,ssp01,ssp03,ssp10,ssp07,print := ssp08.2; [ REAL YD ]

cycle
  ssp00,ssp01,ssp03,ssp10,ssp07,print := ssp08.2; [ REAL ZD ]

cycle
  ssp03,ssp04,ssp10,ssp08 := ssp00.2; [ REAL*8 CIM(1) ]
```

```
cycle
  ssp03,ssp04,ssp10,ssp08 := ssp00.2; [ REAL*8 CIM(2) ]

cycle
  ssp03,ssp04,ssp10,ssp08 := ssp00.2; [ REAL*8 CIM(3) ]

cycle
  ssp03,ssp04,ssp10,ssp08 := ssp00.2; [ REAL*8 CIM(4) ]

cycle
  ssp03,ssp04,ssp10,ssp08 := ssp00.2; [ REAL*8 CIM(5) ]

cycle
  ssp03,ssp04,ssp10,ssp08 := ssp00.2; [ REAL*8 CIM(6) ]

cycle
  ssp03,ssp04,ssp10,ssp08 := ssp00.2; [ REAL*8 CIM(7) ]

cycle
  ssp03,ssp04,ssp10,ssp08 := ssp00.2; [ REAL*8 CIM(8) ]

cycle
  ssp03,ssp04,ssp10,ssp08 := ssp00.2; [ REAL*8 CIM(9) ]

cycle
  ssp00 := ssp11.1; [ INTEGER IDROP ]

cycle
  ssp00 := ssp02.2; [ mdotV ]

cycle
  ssp00 := ssp05.2; [ mdota ]
  ssp08 := ssp02.2; [ fxvcs ]

cycle
  ssp08 := ssp02.2; [ fyvcs ]
  ssp07 := ssp01.2; [ REAL*8 RMIR(1) ]

cycle
  ssp08 := ssp02.2; [ fzvcs ]
  ssp07 := ssp01.2; [ REAL*8 RMIR(2) ]

cycle
  ssp00 := ssp02.2; [ mxvcs ]
  ssp07 := ssp01.2; [ REAL*8 RMIR(3) ]

cycle
  ssp00 := ssp02.2; [ myvcs ]
  ssp07 := ssp01.2; [ REAL*8 VMIR(1) ]

cycle
  ssp00 := ssp02.2; [ mzvcs ]
  ssp07 := ssp01.2; [ REAL*8 VMIR(2) ]

cycle
  ssp08 := ssp05.2; [ fxacs ]
  ssp07 := ssp01.2; [ REAL*8 VMIR(3) ]

cycle
  ssp08 := ssp05.2; [ fyacs ]
  ssp01 := ssp03.4; [ REAL*8 GRT(01,01) ]

cycle
  ssp08 := ssp05.2; [ fzacs ]
```

```
  ssp01 := ssp03.4; [ REAL*8 GRT(01,02) ]

cycle
  ssp00 := ssp05.2; [ mxacs ]
  ssp01 := ssp03.4; [ REAL*8 GRT(01,03) ]

cycle
  ssp00 := ssp05.2; [ myacs ]
  ssp12 := ssp03.1; [ INTEGER IRESLV ]

cycle
  ssp0C := ssp05.2; [ mzacs ]
  ssp12 := ssp03.2; [ REAL*8 LAMDXX(01) ]

cycle
  ssp05 := ssp11.2; [ REAL*8 ACSLEV ]
  ssp12 := ssp03.2; [ REAL*8 LAMDXX(02) ]

cycle
  ssp05 := ssp11.2; [ REAL*8 DTACSA(01) ]
  ssp12,ssp09 := ssp03.2; [ REAL*8 LAMSEK(01) ]

cycle
  ssp05 := ssp11.2; [ REAL*8 DTACSA(02) ]
  ssp12,ssp09 := ssp03.2; [ REAL*8 LAMSEK(02) ]

cycle
  ssp05 := ssp11.2; [ REAL*8 DTACSA(03) ]
  ssp12,ssp09,print := ssp03.2; [ REAL*8 MAGRTR ]

cycle
  ssp05 := ssp11.2; [ REAL*8 DTACSA(04) ]
  ssp01,print := ssp03.4; [ REAL*8 RTIC(01,01) ]

cycle
  ssp05 := ssp11.2; [ REAL*8 DTACSB(01) ]
  ssp01,print := ssp03.4; [ REAL*8 RTIC(01,02) ]

cycle
  ssp05 := ssp11.2; [ REAL*8 DTACSB(02) ]
  ssp01,print := ssp03.4; [ REAL*8 RTIC(01,03) ]

cycle
  ssp05 := ssp11.2; [ REAL*8 DTACSB(03) ]
  ssp01 := ssp03.4; [ REAL*8 VTIC(01,01) ]

cycle
  ssp05 := ssp11.2; [ REAL*8 DTACSB(04) ]
  ssp01 := ssp03.4; [ REAL*8 VTIC(01,02) ]

cycle
  ssp02 := ssp11.2; [ REAL*8 DTOFFV(01) ]
  ssp01 := ssp03.4; [ REAL*8 VTIC(01,03) ]

cycle
  ssp02 := ssp11.2; [ REAL*8 DTOFFV(02) ]
  ssp10 := ssp00.2; [ REAL*8 PD ]
  ssp07 := ssp01.2; [ REAL*8 AT(1) ]

cycle
  ssp02 := ssp11.2; [ REAL*8 DTOFFV(03) ]
  ssp10 := ssp00.2; [ REAL*8 QD ]
  ssp07 := ssp01.2; [ REAL*8 AT(2) ]
```

```
cycle
  ssp02 := ssp11.2; [ REAL*8 DTOFFV(04) ]
  ssp10 := ssp00.2; [ REAL*8 RD ]
  ssp07 := ssp01.2; [ REAL*8 AT(3) ]

cycle
  ssp05 := ssp11.1; [ INTEGER ITHRES ]

cycle
  ssp02 := ssp11.1; [ INTEGER IVCS ]

cycle
  ssp02 := ssp11.1; [ INTEGER IVTAB ]

cycle
  ssp05 := ssp11.2; [ REAL*8 TATAB ]

cycle
  ssp02 := ssp11.2; [ REAL*8 TBURNM ]

cycle
  ssp02 := ssp11.2; [ REAL*8 TIMONV ]

cycle
  ssp02 := ssp11.2; [ REAL*8 TOFFLT(01) ]

cycle
  ssp02 := ssp11.2; [ REAL*8 TOFFLT(02) ]

cycle
  ssp02 := ssp11.2; [ REAL*8 TOFFLT(03) ]

cycle
  ssp02 := ssp11.2; [ REAL*8 TOFFLT(04) ]

cycle
  ssp02 := ssp11.2; [ REAL*8 TVTAB ]

cycle
  ssp11 := ssp05.1; [ INTEGER IACSON ]

cycle
  ssp10 := ssp08.2; [ REAL*8 UD ]
  ssp11 := ssp07.2; [ REAL*8 VG(1) ]

cycle
  ssp10 := ssp08.2; [ REAL*8 VD ]
  ssp11 := ssp07.2; [ REAL*8 VG(2) ]

cycle
  ssp10 := ssp08.2; [ REAL*8 WD ]
  ssp11 := ssp07.2; [ REAL*8 VG(3) ]

cycle
  ssp11,ssp12 := ssp01.2; [ ti2m(1) ]

cycle
  ssp11,ssp12 := ssp01.2; [ ti2m(2) ]

cycle
  ssp11,ssp12 := ssp01.2; [ ti2m(3) ]

cycle
  ssp11,ssp12 := ssp01.2; [ ti2m(4) ]
```

```
cycle
  ssp11,ssp12 := ssp01.2; [ ti2m(5) ]

cycle
  ssp11,ssp12 := ssp01.2; [ ti2m(6) ]

cycle
  ssp11,ssp12 := ssp01.2; [ ti2m(7) ]

cycle
  ssp11,ssp12 := ssp01.2; [ ti2m(8) ]

cycle
  ssp11,ssp12 := ssp01.2; [ ti2m(9) ]

cycle
  ssp11,ssp12 := ssp01.2; [ VREL(1) ]

cycle
  ssp11,ssp12 := ssp01.2; [ VREL(2) ]

cycle
  ssp11,ssp12 := ssp01.2; [ VREL(3) ]

cycle
  ssp11,ssp12 := ssp01.2; [ RREL(1) ]

cycle
  ssp11,ssp12 := ssp01.2; [ RREL(2) ]

cycle
  ssp11,ssp12 := ssp01.2; [ RREL(3) ]

cycle
  ssp11 := ssp01.2; [ sp ]

cycle
  ssp11 := ssp01.2; [ sq ]

cycle
  ssp11 := ssp01.2; [ sr ]

cycle
  ssp12 := ssp11.2; [ magr ]

cycle
  ssp12 := ssp11.2; [ magv ]

cycle
  ssp12,print := ssp11.2; [ tgo ]

cycle
  ssp12 := ssp11.2; [ piter ]

cycle
  ssp12 := ssp11.2; [ roller ]

cycle
  ssp12 := ssp11.2; [ yawer ]

cycle
  ssp12 := ssp11.1; [ iburn1 ]
```

```
cycle
  ssp12 := ssp11.2; [ lamd(1) ]

cycle
  ssp12 := ssp11.2; [ lamd(2) ]

cycle
  ssp12 := ssp11.1; [ acqd ]

cycle
  ssp11 := ssp12.1; [ estate ]

cycle
  ssp11 := ssp12.2; [ piter ]

cycle
  ssp11 := ssp12.2; [ roller ]

cycle
  ssp11 := ssp12.2; [ yawer ]

cycle
  ssp11 := ssp12.1; [ iburn1 ]

cycle
  ssp11 := ssp12.2; [ lamd(1) ]

cycle
  ssp11 := ssp12.2; [ lamd(2) ]

cycle
  ssp11 := ssp12.1; [ acqd ]

cycle
  ssp11 := ssp12.2; [ tge1 ]

cycle
  ssp11 := ssp12.2; [ tge2a1 ]

cycle
  ssp11 := ssp12.2; [ trmtgo ]
```